TEXT BOUND
INTO
THE SPINE

"A DISAGGREGATE TRIP GENERATION MODEL FOR THE STRATEGIC PLANNING CONTOL OF PRIVATE CAR TRIPS TO LARGE FOODSTORES"

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VOLUME 1 - THE TEXT

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This thesis is dedicated to my Father and Mother who, through their love, sacrifice and vision made it all possible.

G. McL. Hazel, July 1985.

For I was my father's son, tender and only beloved in the sight of my mother. He taught me also, and said unto me, Let thine heart retain my words : keep my commandments, and live. Get wisdom, get understanding : forget it not; neither decline from the words of my mouth. Forsake her not, and she shall preserve thee : love her, and she shall keep thee.

Proverbs 4 : 3-6.

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CHAPTER ONE
THE GROWTH OF LARGE FOODSTORES IN BRITAIN

1.1 Introduction

This thesis sets out to provide a model for the calculation of private car trips to large foodstores based on local area household characteristics. It recognises the weakness in predicting private-car trips to large stores using trip-rates obtained from surveys of stores in other areas. The trip generation model that is sought must be easily applied and must use readily accessible data. It is proposed therefore that a relationship be sought between private- car trips to the stores and the household characteristics, obtainable from census data, of the local catchment area. The model thus obtained would be used for strategic planning control.

The initial chapters set out the scale of growth of large foodstores in Britain and the consequent problems they create for the road network and the local environment. The conceptual framework and research objectives are then discussed and related to the research tasks and the methods of analysis required to achieve the research objectives. The resulting trip generation model is fully examined, to understand the relationships established within the model, and then applied to future development within an established aggregate distribution and assignment model.

The first chapter therefore highlights the growth of large foodstores in Britain and abroad. It discusses the general factors which have combined to encourage this growth and examines the future of this form of retailing in Britain.

1.2 The last 15 years have seen a phenomenal growth in large food retailing stores in Great Britain. Jones[1] estimates that this growth is the equivalent of providing gross floor-space equal to 20 shopping centres the size of Brent Cross. In terms of their size, locational requirements and characteristics, these stores have altered the pattern of shopping centres and the shopping behaviour of millions of householders on a scale unprecedented in the history of the British retail trade.

The Unit for Retail Planning Information (URPI) estimates that a total of 230 large stores, comprising 42 hypermarkets and 188 superstores were open and trading at the end of 1982.[2] URPI define a hypermarket as a store with over 5,000 m^2 selling area and a superstore as a store between 2,500 m^2 and 5,000 m^2 selling area. In 1977 there were 140 stores trading, based on these URPI definitions. Figure 1 shows the rapid growth in British hypermarket and superstore openings between 1961 and 1981.

1.3 During the 1960's this form of retailing expanded rapidly in Europe, accounting for 10% of the retail trade in some countries.[3] In France, for example, the first hypermarket was constructed in 1967 and there are now in excess of 305, each with a sales area greater than 2,500 m^2.[3] The six largest hypermarkets in France are operated by Carrefour and include a store at Toulouse with 67 checkouts, parking for 4,000 private cars and is twice the size of the largest store operated by any of Carrefour's competitors.[3] Figure 2 and Table 1 show the growth rate of these stores in France.

1.4 In the United States of America the out-of-town hypermarket showed a similar growth pattern. In 1950 the average store size was 400,000 ft^2 of retail floor space; by 1960 this had risen to over 750,000 ft^2. In this period the number of large retail centres rose from 2,000

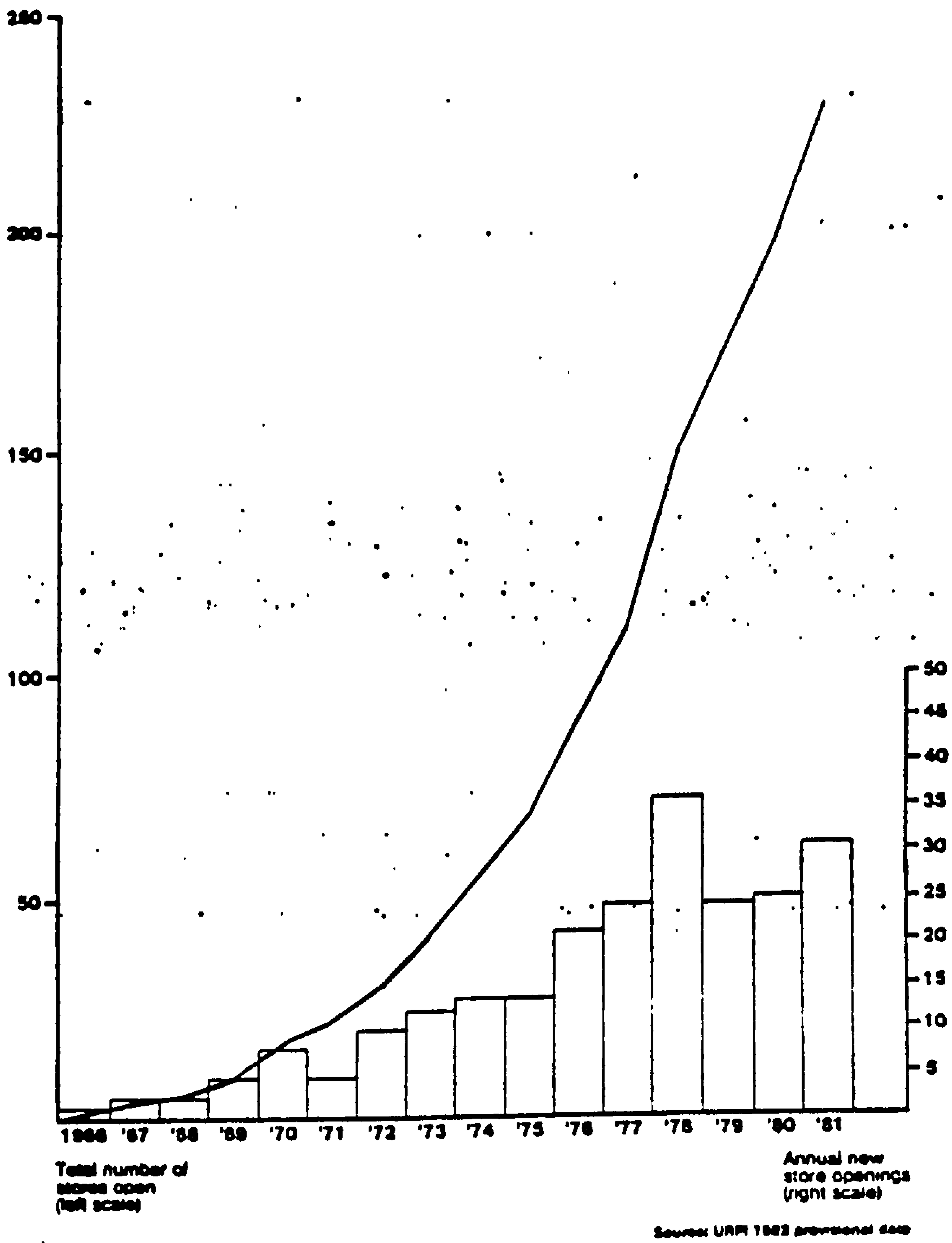


FIGURE 1

British hypermarket and superstore openings 1966-1981

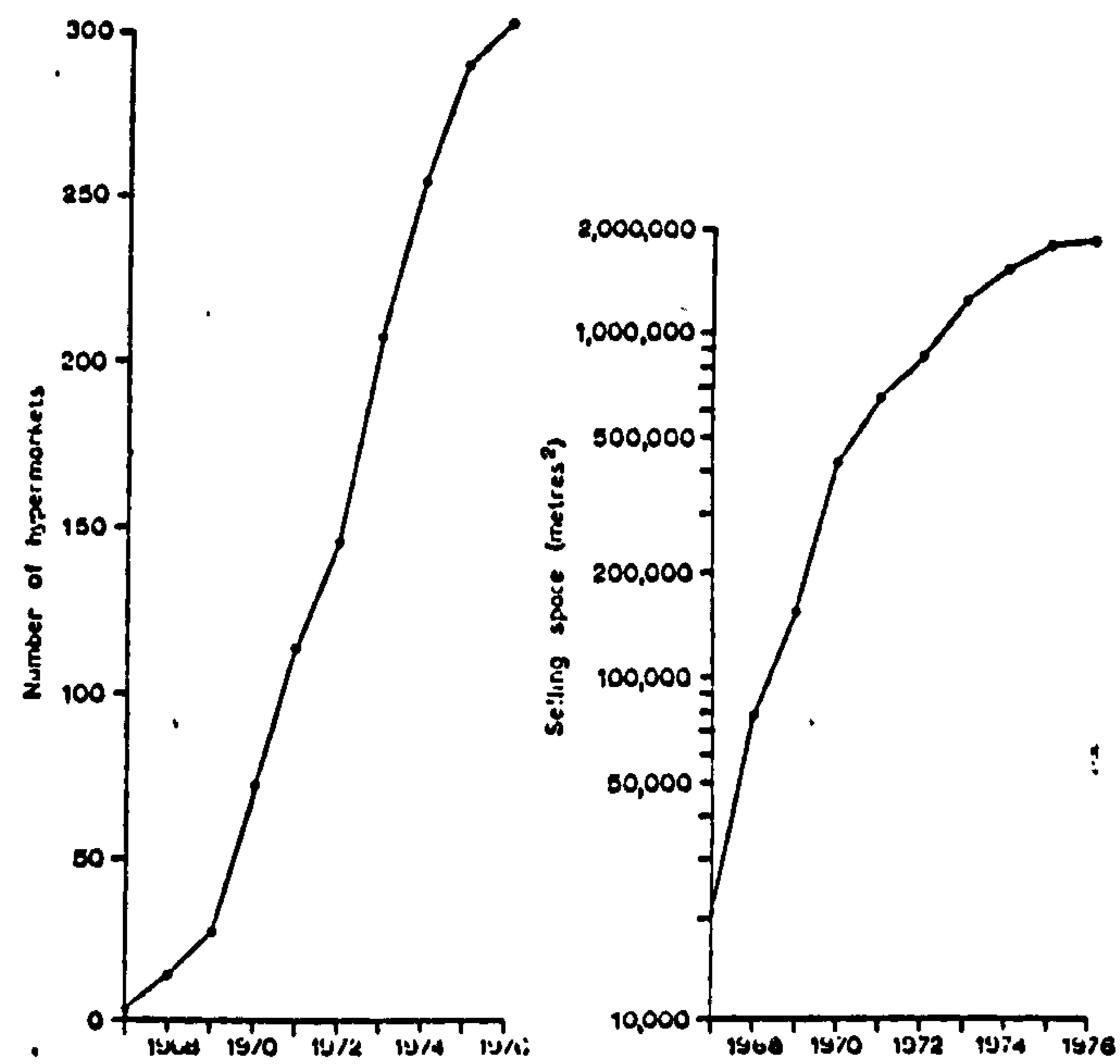


FIGURE 2

Growth in number and sales space of French hypermarkets

Source: Geography, Vol.61, Pt.4, 1976

Number of employees	Sales area (m²)						
	2500–4999	5000–7499	7500–9999	10 000–14 999	15 000 and over	Total	Percentage
1–34	1	0	0	0	0	1	0
35–99	46	0	0	0	0	46	16
100–149	47	8	1	0	0	56	19
150–199	26	19	4	0	0	49	17
200–249	10	23	7	3	0	43	15
250–299	3	26	17	2	0	48	16
300–399	0	9	11	14	1	35	12
400 and over	0	3	3	5	4	15	5
Total	133	88	43	24	5	293	
Percentage*	46	30	14	8	2		100

* Percentage refers to all 305 stores.
SOURCE: "Atlas des hyper et supermarchés au 1er janvier, 1976", *Libre Service Actualités*, 561–2.

TABLE 1

Size of French Hypermarkets in 1975

to 11,200 and this continued into the seventies adding 1000 to 1200 new stores each year.[4] The North American developments have taken the form of regional shopping centres, usually situated well outside suburban areas.

1.5 The growth of the large retail foodstore has been experienced in most developed countries. Documented evidence has been produced to substantiate this trend in Ireland[5], West Germany[6], Switzerland[7] and Japan[8] in addition to France and the USA mentioned above. This pattern of growth is continuing and Jones, in his paper on the saturation level of hypermarket and superstore provision,[1] concludes that it is not possible to predict saturation in a market as dynamic and uncertain as retailing due to problems of definition, qualitative factors, changes in marketing and management techniques and the difficulty in forecasting development opportunity. This is supported by Sheth[9] in his examination of future retailing trends.

1.6 In contrast to the somewhat explosive development in certain countries the pattern of growth in Britain has been slower and smaller in scale. In 1970 24 large stores were in existence, the majority operated by Asda and Woolco[2] and situated in the North of England. Since then development has accelerated, as shown in Table 2.

1.7 As in other countries this trend is continuing. Safeway Food Stores, for example, had 82 outlets in 1975 and 110 in 1983, giving a rise in total sales area from 781,000 ft^2 to 1,005,000 ft^2.[10] Kwik Save Discount Group PLC had 156 outlets in 1978 and 306 outlets in 1982, with 30 planned for 1983.[11] Associated Dairies Group PLC had 12 warehouses and 32 branches in 1972. This had risen in 1983 to 72 warehouses and 88 branches[12]. The British situation, although less dramatic than the growth patterns of France or the USA, nevertheless constitutes a major

YEAR	HYPERMARKETS	SUPERSTORES	TOTAL
1967	2	1	3
1971	6	22	28
1974	14	61	75
1977	31	109	140
1981	42	188	230

Source: URPI U7, 1978

TABLE 2

Growth in Hypermarkets and Superstores in Great Britain, 1967-1981 change in retailing pattern with major consequences for the urban environment. The report, commissioned by Glasgow Corporation,[13] on shopping centres and hypermarkets in the Glasgow area highlights these consequences and requires planning authorities to understand the reasons for this growth so that it can be effectively controlled.

1.8 The reasons for the emergence of hypermarket and superstore shopping have been well documented and can be classified into two broad areas; changes in methods of store management and retailing and changes in consumers' mobility and accessibility.[1,2,9,13,14,15]

The scale of operating enables the retailer to achieve economies by optimising merchandising techniques and by introducing new management methods such as direct purchasing, mechanical goods handling in-store and devolved departmental management responsibility, thereby offering discounted prices to the consumer. Increasing car ownership levels[16] and improving accessibility to large stores have enabled consumers to take advantage of these economies of scale. These factors are more fully discussed by Parker[5], Pacione[14] and others. (9,15,17,18)

1.9 The increased accessibility offered by these stores coupled with traffic congestion and restraint policies within city centres, has led to an increase over time in store size. Tesco, for example, have increased the percentage of total sales area of stores over 25,000 ft^2 from 11% to 40%, between 1975 and 1981.[19] Thus the one-stop shopping, associated with large foodstore retailing, has become an established and growing section of the retail market. It is generally agreed, by most retail commentators,[9,14,17,18] that this growth will continue and this form of shopping will significantly affect the retail hierarchy of Britain. The next chapter discusses the impact these stores have had on the traffic movements of urban areas and the local environment and the consequent problems that have been caused.

CHAPTER 2

THE DEFINITION OF STORE TYPE AND THE ESTIMATION OF PRIVATE-CAR TRIPS TO LARGE RETAIL CENTRES

2.1 Introduction

The chapter begins with an examination of store types and their definitions as this is related to trip rate. This is also necessary to establish the scope of any predictive model that may be developed.

It is shown that the definitions of hypermarkets, superstores and supermarkets are arbitrary and based on floor size. The regional centre can be separately identified. This thesis relates to the former three shop types.

The existing predictive methods, for trip arrival and parking provision at each store, are then discussed and are shown to be unsatisfactory; their specific and empirical nature being inappropriate in the general case. It is suggested that a trip generation model based on local area characteristics be developed which must be easily applied and economical. For these reasons the model should be based on census data and provide an input to a compatible distribution model which allows for competition.

2.2 The Definition of Store Types with respect to Current Practise

2.2.1 In Britain large retail stores vary in size and title from the regional shopping centre to the local supermarket. Therefore when attempting to model private-car trips to large retail stores one must establish the scope of the predicting model. To do this it is necessary to review the current definitions of each type.

2.2.2 It has been quoted, in the previous chapter,[1] that there were in 1981, 230 superstores in Britain. This does not include 70 stores classed as supermarkets but marginally smaller than the cut-off figure, who generate similar levels of private-car traffic.[2] The form of definition can therefore significantly change the level of activity.

2.2.3 The regional shopping centre however, can be classified as distinct from the individual large store in that it differs in sales technique, range of goods offered, number of shops involved and traffic characteristics.[20] The regional shopping centre usually has at least one large department store in addition to many small shops. The sales approach is one of comparison shopping, the consumer being able to choose between several retail units.

2.2.4 The distinction between hypermarkets, superstores and supermarkets is less obvious. They all emphasise convenience goods displayed in one large store and previous and current definitions tend to emphasise the scale factor difference between store types. France defines the hypermarket as follows :[3]

a) a retail unit of at least 2,500 m^2 (22,500 ft^2) sales area on one floor selling a wide range of low-priced food and a more general range of non-food goods.

b) a ground level car park at least three times the sales area of the store.

c) self service principles throughout.

Harris and Andrew[21] define hypermarkets as having a sales area greater than 50,000 ft^2 and superstores, a sales area greater than 25,000 ft^2. Pacione[14], in commenting that no definitions have been generally agreed, chooses a figure of 6,000 m^2 (60,000 ft^2) sales area to define the hypermarket.

2.2.5 The Unit for Retail Planning Information (URPI) defines hypermarkets and superstores as single level, self-service stores offering a wide range of food and non-food merchandise, with at least 50,000 ft^2 of sales area for the hypermarket and 25,000 ft^2 of sales area for the superstore. They must also be supported by adequate car parking. These definitions do not recognise characteristic differences but use the sales area as the basis of definition. Parker[5] again bases his definitions on sales area but chooses 20,000 ft^2 of selling space as the minimum area necessary for the definition of a superstore.

2.2.6 The current literature therefore bases the definitions of hypermarkets and superstores on sales area and the variation in definition produces a wide range of defined hypermarkets and superstores in Britain e.g. the number of hypermarkets varies from 3 to 38 depending on the definition adopted. The characteristics listed by the authors mentioned above are vague and talk in generalities lacking a uniform definition. Supermarkets are not mentioned except for Jones[1] commenting on the false divisions imposed by definitions based on sales area. It is clear that size of store is at best unsatisfactory and that other factors such as local catchment area characteristics, location and competition must influence the performance of any given store.[22] This is underlined by the fact that the same store could be defined as either a hypermarket or superstore, depending on the sales area definition used, and different trip rates would be applied.

2.2.7 It is proposed therefore to avoid such distinctions between hypermarkets, superstores and supermarkets and use the general term large foodstore where appropriate since in reality the differences in the British context are more to do with the locational factors mentioned above rather than any intrinsic difference caused by size. That is the location is directly related to the accessibility and attractiveness of the store and will affect the distribution of shopping trips within the retail, competitive framework of the area. If the trips generated are modelled on household characteristics and are separated from the distribution to individual stores the definition problem is irrelevant. This postulation will be expanded in the chapter on conceptual framework.

2.2.8 The previous chapter outlined the historical growth of large retail centres and showed their continuing presence in today's retail hierarchy. The size of these stores attracts large numbers of shoppers, predominantly arriving by private-car, and ensures a major impact on the local area, just as any major traffic generator. This raises issues of development control which must be faced by transport planners and leads to a trade-off between retail efficiency and environmental protection.[24] The traffic pattern generated and the consequent social and engineering problems have to be understood and dealt with and the next section of this chapter examines the current methods of trip generation estimation from which development control decisions are made.

2.3 The Problem of Private-Car Trips Attracted to Large Foodstores

2.3.1 It has been argued that large, one-stop shopping stores are an established part of the retail hierarchy and that their size and consequent traffic generation requires control of their development. The particular characteristic that this thesis addresses itself to is the generation of private-car trips to these stores. The percentage of private car trips varies from store to store depending on store type and catchment area characteristics but is invariably between 70% and 90%.[21,22,23,24] Harris and Andrew[21] argue that the scale of trips attracted and the parking provision required compares with the level of trip attraction of a regional airport the size of Turnhouse, Edinburgh and therefore requires the same careful planning and design. The Minworth-Carrefour store generated, in 1979, between 6,300 to 8,500 daily trips with the road access having to cope with up to 1000 vehicle arrivals in the peak hour. The store is situated adjacent to a major road. The Fine Fare, Stirling store was sited within a council housing estate with only a roof car park which catered for 180 cars. The result was that within weeks of the store opening Prohibition and Restriction of Waiting Orders had to be introduced on the residential streets around the store. The local residents suffer severe vehicle intrusion. Aitken & Malcolm[24], in studying this store, conclude that the introduction of a hypermarket or superstore into an area where the road network is not designed to carry the additional, generated traffic is undesirable. It would appear therefore that in permitting a large, one-stop, foodstore development to proceed, transport planners must ensure that the surrounding road network is capable of supporting the increased load that will be imposed upon it. The method of estimating these trips will now be discussed.

2.4 Current Techniques for the Estimation of Trips Attracted to Large Foodstores

2.4.1 The current method used for the estimation of trips to large stores is either based on Gross Floor Area (GFA) or Net Floor Area (NFA), the latter can also be referred to as sales area, selling area or retail area. Parking requirements are calculated using the same empirical methods which involve comparison of trip rates, established from surveys of stores in other locations, with the store being considered. Harris & Andrew(21) support this method.

2.4.2 Table 3 shows the results of two British studies which suggest an optimum trip rate/1000 ft^2 GFA when the store has built up a demand from its catchment area. The two stores listed show an agreement between the sets of figures but this pattern is not substantiated when a wider sample is taken. Table 4 is extracted from a letter, in response to Harris & Andrew's(21) paper, from Maltby & Johnson(25) of Salford University. The overall variation in this small sample is approximately 80 trips/1000 ft^2 NFA. For a medium-sized store of say 50,000 ft^2 NFA this would mean a 4,000 trip variation, a significant difference in terms of road network capacity. In addition there appears to be no obvious relationship between stores of comparable size. This is supported by URPI(2) who found that the link between turnover and floorspace was tenuous. In some instances stores of a similar size had turnovers differing by 100%. They also concluded that no relationship could be found between store size and turnover to floor-space ratios.

2.4.3 It can be seen, therefore, that store and locational characteristics influence trip rates. There is no evidence to suggest a simplistic relationship between floor area and trip rate that can be generally applied with confidence. Indeed, Harris & Andrew[21] concede that trip rate per floor area is only applicable in certain instances and that for practical applications a more refined technique is required which relates trip rates to catchment area characteristics. Leake[22] established, from his Leeds study, a relationship between the peak two-way traffic flow and retail floor area :

$$V = 20Y$$

where V = two-way flow of shopping vehicles (vehs/hr)
Y = retail shopping area (per 100 ft^2)

Aitken & Malcolm[24] dispute the value of the constant in the equation and argue that from their study it appeared to have a value of 13.4. However they qualify their statement by acknowledging a range of values between 13.4 and 17.5. Thus the variation found in Table 4 is present in this equation which takes no account of the catchment area characteristics. Kelly[25] substantiates this store trip-rate variation by quoting figures from his Welsh study. The attraction rates for Asda, Gwent and Asda, Merthyr Tydfil are quoted at 59.3 vehs/1000 ft^2 GFA and Leo's Superstore, Pyle at 54.4 vehs/1000 ft^2 GFA. The Asda stores each having 40,000 ft^2 (59,000 ft^2 GFA) of sales area and Leo's Superstore having 30,000 ft^2 (45,000 ft^2 GFA) of sales area.

2.5 Current Techniques for the Estimation of Private-Car Parking Provision at Large Foodstores

2.5.1 The provision of car-parking at large foodstores shows the same variation as trip-rates. Its under-provision can create accident and environmental consequences and its overprovision is wasteful of land and is environmentally obtrusive. One of the earliest studies of parking at large stores was carried out in 1965 by the

	Total Trips	% of Weekly Total	Trip Rate 1000 ft GFA, Minworth	Trip Rate 1000 ft GFA, Eastleigh
Tuesday	6,399	17.7	43.2	40.1
Wednesday	6,324	17.5	42.7	40.4
Thursday	6,929	19.2	46.8	50.5
Friday	7,896	21.9	53.3	59.1
Saturday	8,536	23.7	57.7	55.4
Total	36,084	100.0	243.7	245.5

Source: Harris & Andrew. (21)

TABLE 3

Trip Rate/1000 ft^{-2} GFA at two British Superstores
(24-hour total, mid-December)

Store Location	Sales Area (ft^2)	Trip Rate/1000 ft^2 Sales Area
Asda, Llandudno	31,000	129.5
Fine Fare, Stirling	34,000	59.1
Gem, Leeds	35,000	69.1
Carrefour, Caerphilly	55,000	70.2
Carrefour, Eastleigh	56,000	116.6
Carrefour, Minworth	70,000	112.8
Tesco, Iram	73,000	63.5
Fine Fare, Hyde	75,000	47.7
Carrefour, Bristol	90,000	87.7

Source: Maltby & Johnson. (25)

TABLE 4

Trip Rate/1000ft^2 Sales Area - a Sample of British Stores

Urban Land Institute[26]. The study was carried out at 270 shopping centres in the USA and Canada during the 12 busiest shopping days of the 1964 pre-Christmas period. The suggested design standard of 5.9 spaces per 100 m^2 GFA was based on the results from 103 shopping centres having neither offices nor theatres.

2.5.2 Early British parking standards followed the recommendations of the Multiple Shop Federation[27] and NEDO[28]. The former converted the American regional standard to the circumstances applying in Britain by allowing for the different levels of car ownership between the two countries. Standards were produced relating to 1969 for high, average and low values of car ownership together with predicted standards for 1975 and 1980. The recommendations only applied to central area shopping facilities. NEDO produced minimum standards which depended on the location of the particular shopping facility. A reduced value of the parking index for central areas reflected the motorist's dislike of congestion, lack of convenient parking facilities and better public transport systems. The higher value of suburban stores reflected their dependence on the private-car.

2.5.3 The NEDO study suggested a minimum of 5.0 parking spaces per 1000 ft^2 of sales area while Aitken & Malcolm[24] suggest 6.7 spaces. Sainsbury superstore at Bretton, Peterborough used a value of 10 spaces per 1000 ft^2 of sales area while Asda have a policy of providing 1 space for every 60 ft^2 of sales area wherever possible, i.e. 16 spaces per 1000 ft^2 sales area. Leake[22] initially suggested a figure of 6.0 spaces per 1000 ft^2 of sales area in areas of high car ownership but published a reappraisal of his work in 1982[29] which took cognisance of household car ownership, petrol facilities and ease of circulation. Table 5 shows the suggested rates. Note that superstores and supermarkets have been grouped together substantiating the argument put forward earlier in the chapter and also the characteristics of the catchment area around the store are beginning to be considered; in this case car ownership. This trend is also seen in a paper by Codd[30] on his work with the City of Glasgow. He suggests a shopping parking prediction model based on shopping centre size and car ownership :

$$\frac{t_{ij}}{c_{ij}} = k\ f(d_{ij})\ \ g(A_j)$$

where t_{ij} = trips from zone i to shopping centre j over a given time period.

C_{ij} = number of cars from zone i at shopping centre j.

A_j = effective area of shopping centre j, a function of convenience and non-convenience floor space.

k = a constant

f,g = functions

d_{ij} = a measure of deterrence between zone i and shopping centre j.

One aspect of his initial findings was the inadequacy of current procedures. The relationship of parking accumulation vis-a-vis GFA was found to have a poor fit to the least squares line. The relationship is not improved if convenience floor space is used.

2.5.4 In France the higher trip rates experienced at hypermarkets has led to the use of a higher parking design ratio than that used for regional shopping centres. The parking ratio for the latter is 6 spaces/100 m^2 GLA, which provides sufficient parking for 350 days a year. As a

	Parking Index (car spaces/100m^2 retail area)	
	Without Petrol	With Petrol
Supermarkets, Superstores	11.0	12.5
Hypermarkets	-	20.5

Source : Leake & Turner. (29)

TABLE 5

Suggested Design P.I. Values for Various Types of Shopping Facilities general rule the ground level car park of a hypermarket is at least 3 times the sales area. The number of parking spaces can also be shown graphically as a function of sales area as shown in Figure 3, (note the discrepancy between the observed and theoretical ratios).

2.5.5 The Distributive Trades EDC in their report[31] recommended that the absolute minimum for parking provision for an out-of-town shopping centre should be 8.5 spaces/1000 ft^2 sales area and that every effort should be made to improve this allocation. This standard was used for the Eastleigh, Carrefour store and was only just adequate to meet the demand. Minworth-Carrefour has 1,280 parking spaces; in line with the recommendations at that time. Kelly[25] suggests that, from experience in Europe, a design figure of 7 to 10 spaces/1000 ft^2 GLA is more pertinent to hypermarkets and superstores however he goes on to quote a value of 5.4 spaces for Asda, Gwent and Asda, Merthyr Tydfil and 3.3 spaces for Leo's Superstore, Pyle. He concludes that the suggested range of 7 to 10 spaces does not compare well with his study where a figure of 10 to 15 spaces/1000 ft^2 GLA was more appropriate.

2.5.6 Maltby & Johnson[25] note that a comparison of parking provision to 38 Carrefour stores on the Continent of Europe with 19 British stores revealed average provisions of 18.8 spaces/1000 ft^2 sales area for European stores and 12.3 spaces/1000 ft^2 sales area for British stores. The authors note that the difference was due to store location, catchment area characteristics and land costs rather than differences in trip generation. This conclusion was based on published data on European and British stores.

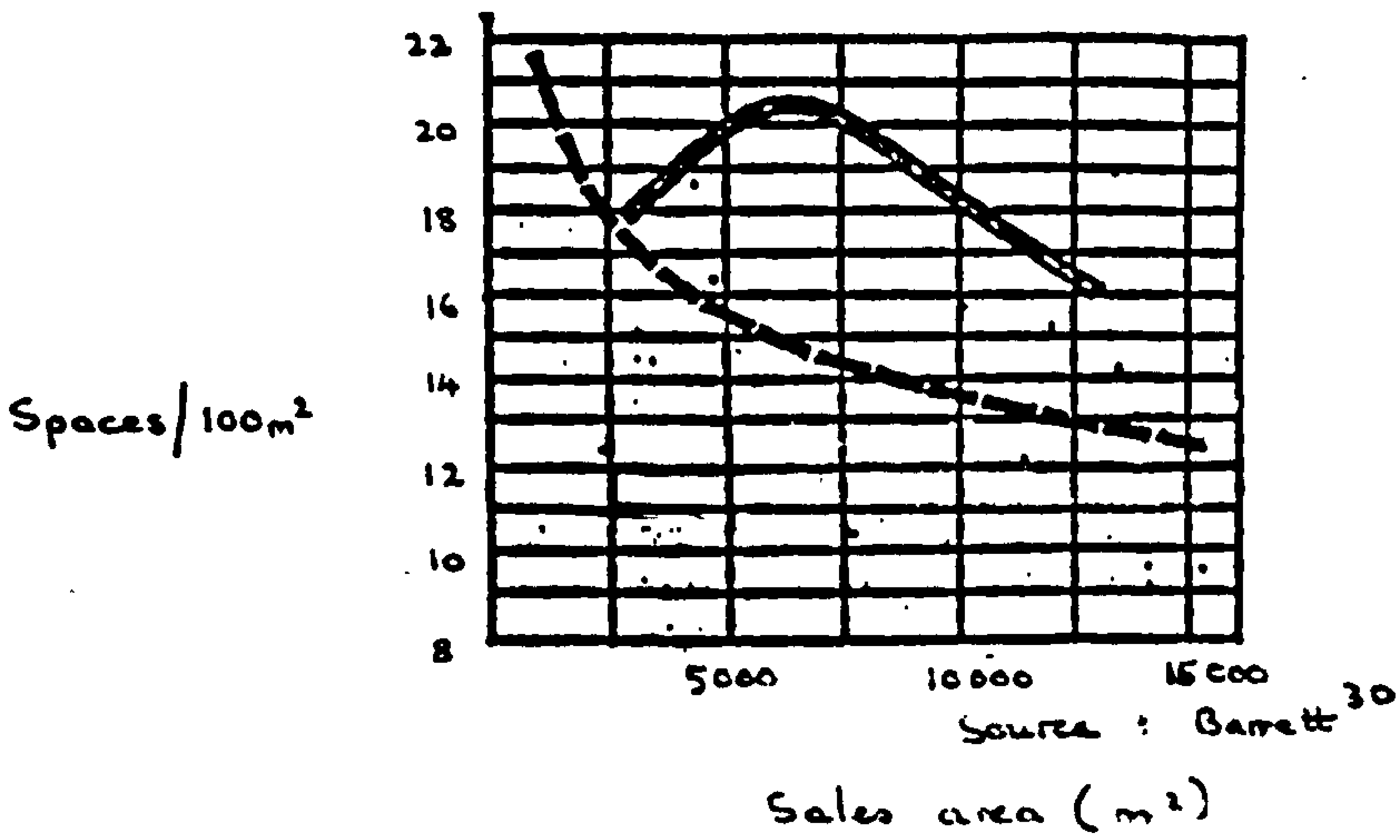


FIGURE 3

Number of parking spaces as a function of sales area in France

------- Ratios proposed by SETRA

_______ Observed ratios (sample of 257 centres)

2.5.7 It is clear therefore, that no generally accepted criteria for the estimation of parking spaces exists and the variation in rates is comparable to that found for trip rates. The Local Authority and developer can choose from a wide range of rates to justify their policy decisions. As with trip rates the methods are empirically based on global factors which are shown to be dependent on the characteristics of the area surrounding the particular store being surveyed. There is no obvious correlation shown between store size and parking space, by inspection of the data. This is substantiated by inspection of a list of every hypermarket and superstore in Britain and their floor area and parking space provision. The list shows no pattern between the two variables (see Appendix A).

2.6 Concluding Remarks

2.6.1 The present method of estimating trip rate and parking allocation is unsatisfactory. The development control officer has to use data from areas considered to be equivalent to the catchment area under study. In practise this means the developer may choose rates sympathetic to his cause and the Local Authority likewise and the resulting compromise may not model the actual demand.

2.6.2 The emerging trend, as indicated in the chapter, is to acknowledge the impact of catchment area characteristics on trip rate and parking provision. This thesis seeks to establish an objective basis which models the relationship between local area characteristics and the usage of large foodstores. The model will estimate the trips generated from the local area and must be easily used by the development control officer. This means that it must be able to be applied quickly and economically and to a level of accuracy compatible with its strategic nature.

2.6.3 The implication of ease of application suggests a model based on area characteristics which can be abstracted from census data. The model must be of a general nature enabling interaction with a general distribution model, taking into account the competitive framework existing between stores in the area. Before discussing the conceptual theory behind this hypothesised relationship it is necessary to identify from consumer behaviour theory and known research findings the characteristics within an area that influence store usage. Once these have been identified the conceptual design and research objectives can be established.

CHAPTER THREE
CONSUMER BEHAVIOUR

3.1 Introduction

The chapter begins by examining store choice and defining it as comprising three parts - access to store, attraction to competing stores and consumer characteristics and needs. A review is then undertaken of current shopping models which seek to emulate the consumer store-choice process. These are also in three parts - the individual store assessment of trips arriving based on floor area, the aggregate models and the disaggregate models. The latter two seek to model the effect of competition between stores.

The chapter argues that, for the strategic planning control of large stores, a disaggregate model is required that predicts private-car trips to stores from the household characteristics of an area. These trips would then be input into a conventional gravity model and distributed to the existing stores. In order to develop this disaggregate model the effect of competition must be removed and this is achieved by randomly selecting groups of households, spatially together, and comparing the relationship developed within each group.

The latter section of the chapter identifies from previous studies the general factors which predict the shopping usage of a household. These are seen to be an employment factor, a household structure factor and an income and social grouping, which could be thought of as a lifestyle factor. From these general factors specific variables are identified. The effects of personal accessibility and spatial accessibility are fully discussed in the following chapter, thus these two chapters form the basis from which the research objectives and conceptual framework can be developed.

3.2 Factors Influencing Store Choice

3.2.1 The previous two chapters have described the empirical method of traffic estimation from large retail stores. This method is based on the relationship between trip rate and the floor area of the store and estimates the trip attraction to a given store from traffic surveys carried out at other stores. Although it is argued that the above relationship exists[22,24] the method does not perform well in practise due to the different characteristics of each store and its environs.

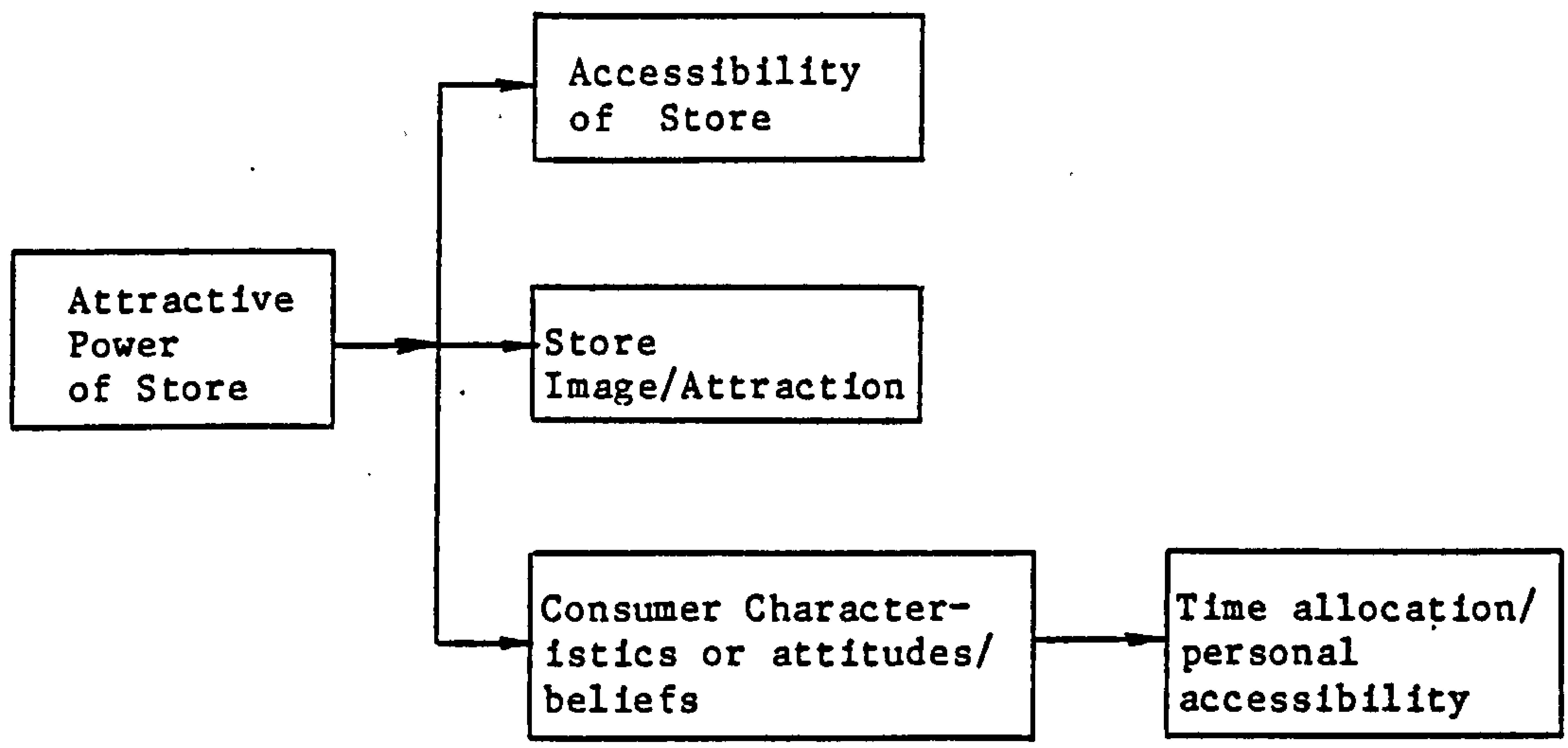
3.2.2 This study is concerned with the estimation of private-car, shopping trips to large foodstores. This has been approached in three ways :

1) the empirical method, used by most development control planners, based on floor area. This pertains to an individual store.

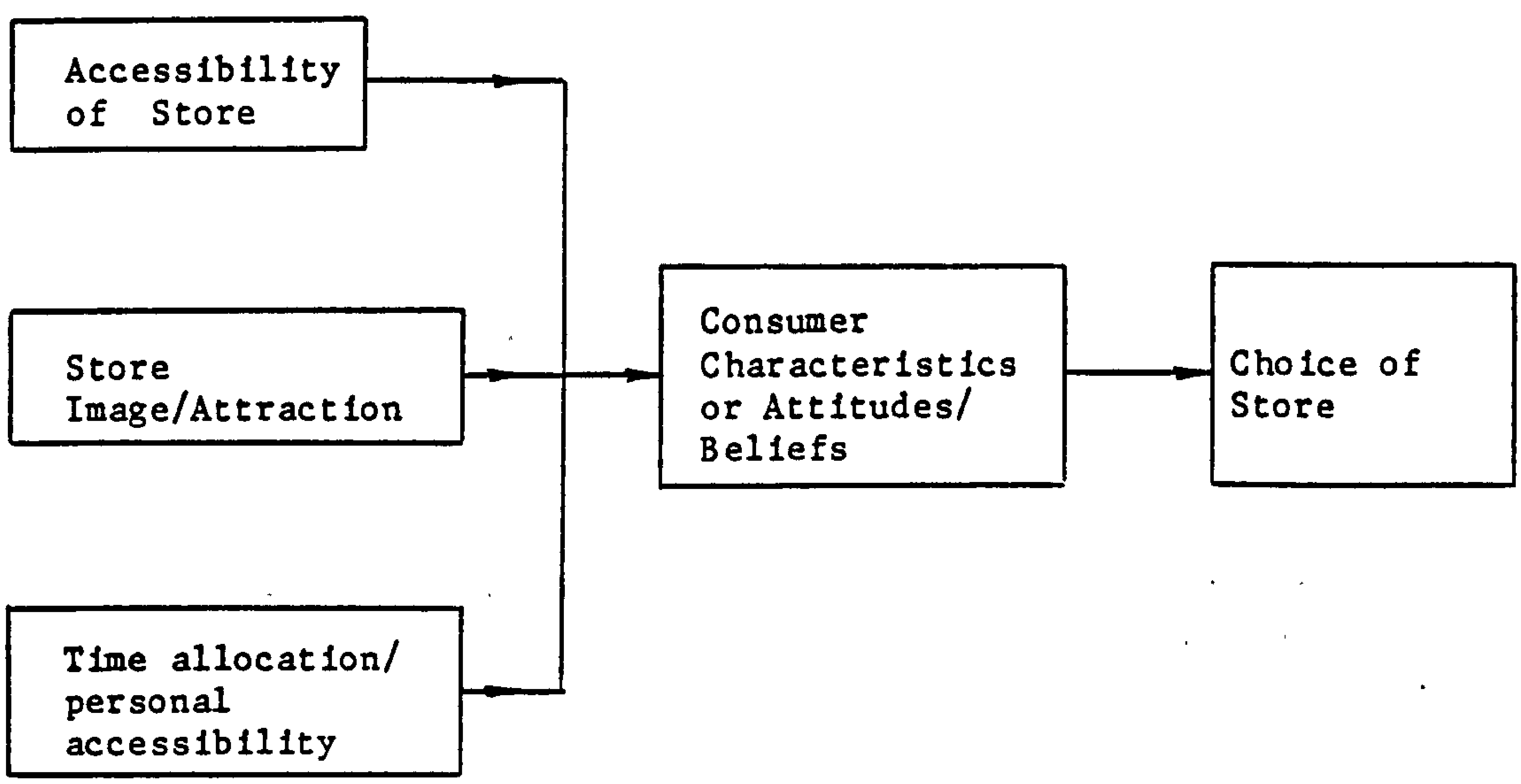
2) aggregate methods of trip estimation within a competing framework of existing stores. Again based at the store-end.

3) disaggregate methods of trip estimation based at the consumer end. These methods seek to explain and model the nature of the individual consumer's choice.

3.2.3 The understanding of the consumer choice mechanism has attracted much study and a review of the work to date identifies three broad areas which make up this mechanism i.e. the characteristics or attitudes/beliefs of the consumer, the accessibility of the store and the attraction of the store, or the store image.[32,33] This can be thought of as store-based or consumer-based i.e. :


Accessibility of Store
Attractive Power of Store
Store Image/Attraction
Consumer Characteristics or attitudes/ beliefs
Time allocation/ personal accessibility

OR :


Accessibility of Store
Store Image/Attraction
Time allocation/ personal accessibility
Consumer Characteristics or Attitudes/ Beliefs
Choice of Store

3.3 Analytical Approaches to Consumer Behaviour

3.3.1 The Gravity Model

One of the earliest and best known applications of the gravity model is the retail location model developed by Lakshmanan & Hansen[34] from the work of Reilly.[35] The model allocates consumer expenditures from residential zones i to shopping centres j subject to the constraint :

$$S_{ij} = \sum_i C_i P_i$$

S_{ij} are the sales made by vendors in j to consumers in i and C_i is the per capita expenditure on consumer goods in i. The model is,

$$S_{ij} = A_i C_i P_i W_j^{\lambda_1} d_{ij}^{-\lambda_2}$$

where $$A_i = \frac{1}{\sum_j W_j^{\lambda_1} d_{ij}^{-\lambda_2}}$$

W_j is a measure of shopping centre attraction in j and are parameters of the model.

In this type of model the attraction of the store (W_j) is usually a simplistic measure such as retail floor area, although other terms reflecting range of goods, etc., can be added.[36] The accessibility term is the deterrence function $W_j^{\lambda_1} d_{ij}^{-\lambda_2}$ and the consumer term is modelled by population (P_i) and per capita expenditure (C_i). The advantage of such a model is its ease of application for strategic modelling and indeed the concept of "gravitational" attraction has been proved from empirical studies to be sufficiently accurate for this type of modelling.[37] The disadvantage is its aggregate nature which relies on the calibration of the model parameters and the deterrence function with respect to a given area.

The calibration of these parameters and function can be both costly and time consuming.

3.3.2 Probabilistic Choice Models

The search for a model which more accurately reflected the consumer's choice pattern led to the extension of the one-centre gravity model to an interacting network of shopping centres. To describe this many-centre interaction the probabilistic notion of competition is introduced. Huff[38] showed that the probability of a given centre j being chosen from a closed set of centres is :

$$P_j = \frac{U_j}{\sum_j U_j}$$

where U_j is the utility associated with the jth centre. The utility of the centre j for a particular consumer is indexed by the ratio of the attractive power (A_j) of the centre to the distance (d_{ij}) of the centre to the consumer i.e.

$$P_{ij} = \frac{A_j^{\alpha} / d_{ij}^{\beta}}{\sum_j A_j^{\alpha} / d_{ij}^{\beta}}$$

This can then be developed in terms of sales by multiplying P_{ij} by the retail expenditure of the consumers in zone i.[32] The model is similar in structure to the gravity model but attempts to relate the sales emanating from a zone to the probability that a consumer will choose a certain store. The concept of the competitive framework is also an advance towards a more realistic modelling of the choice mechanism of a consumer, compared with the one-centre gravity model.

Harris[39], from a model originally proposed by Stouffer[40], developed a retail location model which contained specific provision to vary demand for different classes of population and to vary consumer behaviour in proportion to the density of shopping opportunities. The basic formalism derived by Harris is,

$$\rho = \frac{-dQ}{dV} = f(L)Q$$

and the probability of a shopping trip continuing beyond V is,

$$R = \int_{L=0}^{\infty} f(L)Q \, dL$$

where		=	probability distribution function
	V	=	the number of opportunities
	L	=	the probability that a consumer will be satisfied by a particular commodity
	Q	=	the probability that the consumer has not been satisfied with the first 'x' number of opportunities

Harris used a gamma distribution for f(L). This is developed to the generalised form,

$$R = (L + b_1 W)^{-a_1} L(L + b_2 D)^{-a_2} e^{-(c_1 W + c_2 D)}$$

where $W = V + D$

D = distance to the next opportunity.

The model contains seven parameters and these can be reduced depending on the value these parameters take. For example, if a = b = c = 0 then the gravity model is obtained. For a detailed exposition of the model development the reader is referred to a report by Cordey-Hayes.[32]

Wilson[41] developed an approach based on maximum entropy which had as its basic hypothesis that the probability of a particular trip distribution occurring is proportional to the number of states that can give rise to the distribution. The number of distinct arrangements $W(T_{ij})$ that can give rise to the distribution (T_{ij}) is,

$$W(T_{ij}) = \frac{T!}{\prod_{ij} T_{ij}!}$$

where T is the total number of trips. The total number of possible states is then,

$$W = \sum_i \sum_j W(T_{ij})$$

The procedure is to maximise $W(T_{ij})$, subject to the imposed constraint, to give the most probable distribution. Both the gravity model and the intervening opportunities model, developed by Harris,[39] can be derived from this approach.

A further two models that have been developed are the logit and probit models. The basic form of the logit model is,

$$P_c = \exp V_c / \sum_{k \varepsilon k} \exp V_k$$

giving the probability P_c that a traveller will be attracted to a grouping c of elementary alternatives, given that a set K = $\{\ldots.\ k\ \ldots\}$ of such groupings is available to him. V_k is the utility of grouping k. The model is disaggregate in the sense that it predicts the choice of an individual.

This model can be derived from the gravity model by considering each individual trip-maker in zone i as making one of the O_i trips from that zone, i.e.

$$P_j = \frac{T_{ij}}{O_i} = \frac{B_j f_{ij}}{\sum_k B_k f_{ik}}$$

where P_j = the probability that the individual in zone i will travel to zone j.

If $V_k = \log (B_k F_{ik})$ the basic logit model can be derived. A fuller explanation of this type of model is given by Daly.(42) An extension of the above is the multinomial logit model which can be written,

$$P(d, m : DM_t) = \frac{e^{Udmt}}{\Sigma e^{Udmt}}$$

where $(P(d, m : DM_t)$ is the probability that individual t will choose destination d and mode m from the full set of alternative destinations and modes open to him; $DM_t . U_{dmt}$ is the utility individual t obtained from going to destination d by mode m. This model was used for the distribution of shopping trips in Holland in 1975.(43)

Probit analysis assumes that there is a threshold P for degree of preference for the store to be chosen. That is a consumer will decide to shop at a store only if his or her degree of preference is above the threshold. A linear representation of this, as used by Malhotra(44), is

$$P = \sum_{i=o}^{R} \beta_i x_i$$

where x_1, x_2, ... x_R represent salient store image characteristics. The model then attempts to explain store choice directly in terms of store image characteristics and thereafter to forecast consumer expenditure.

3.3.3 Attitudinal Approaches

A further approach to the understanding of the consumer choice mechanism involves attitudinal modelling. This area of research, as applied to retail behavioural modelling, is comparatively new and falls into two categories,

a) Studies seeking to model individual psychological or attitudinal responses to choice alternatives, for example the work of Hartgen.[44]

b) Studies seeking to explore the relationships between attitudinal responses and observed behaviours, for example the work of Burnett[45], Cadwallader[46] and Mackay et al[47].

The theory assumes that when individuals evaluate the desirability of alternatives they do so by cognitively integrating their perceptions of the alternatives. The process by which the perceptions of attributes associated with the alternatives are combined into overall evaluations of attitudes may be represented by some form of a multi-attribute utility or value equation. It is assumed that when selecting alternatives, the individual will choose that alternative for which he or she holds the highest overall value or utility.

One of the most influential models in this area of retail marketing research is Fishbein's behavioural intention model[48] which is represented, in summary form, as

$$B \sim I = (A_B)\, W_1 + (SN)W_2$$

where B = a specific overt behaviour under the control of the individual.

I	=	the intention to perform that behaviour
A_B	=	the attitude towards that behaviour
SN	=	the subjective norm or belief that most people who are important to the individual think he or she should perform that behaviour
W_1, W_2	=	empirically determined standardised regression coefficients.

Burnkraut & Page[49], from their research, argued for the validity of this two-component conceptualisation of the determinants of behavioural intention.

The work of Louviere & Meyer[50] also provides preliminary support for the approach. They found that psychological judgements are shown to exhibit high correspondence with real behaviour. This means that if estimates of the psychophysical relationships can be obtained a priori, and such estimates are theoretically true, then the problem of multicollinearity between independent variables can be bypassed. A critical link in the theory is the combination rule or the multi-attribute utility function. Without adequate knowledge of its true form considerable error in model specification is possible. This is a general criticism of attitudinal studies.[50] The major advantage is that they require no revealed behavioural data only observations of evolution under controlled circumstances.

3.3.4 Activity Models

In the last decade researchers have begun examining travel in the context of activities which are demanded at the end of trips. This is a departure from the norm where trips have been considered as commodities. The activity-based approach carries the promise of improved understanding of travel behaviour and an implicit need to define the parameters of interest. These parameters relate to decisions, taken at household level, of whether or not to participate in an activity and for what duration.

Through a review of activity-based models of the past decade Damm[51] isolates three areas into which causal factors can be categorised i.e. activity needs, temporal constraints and spatial constraints. Lenntorp[52] focussed on the potential rather than the actual set of alternatives available. Figure 4 shows the framework of factors affecting activity scheduling. The data required to build activity schedules for each household falls into four categories :

1) the data should at least contain information on the duration of all daily out-of-home activities.

2) an identifier for a person's work status should be present.

3) transportation level of service as well as land-use data is necessary.

4) data on the socio-economic characteristics of the household are required.[51]

This type of data is not readily available and Damm had to use transportation/land-use home interview surveys from Minneapolis/ St Paul. Five equations were then developed for whether or not someone decides to participate in an activity and another five equations for duration were estimated with data on people who participated in an activity in a particular time period.

The above work was of an exploratory nature and called for further research by specific activity e.g. shopping. The

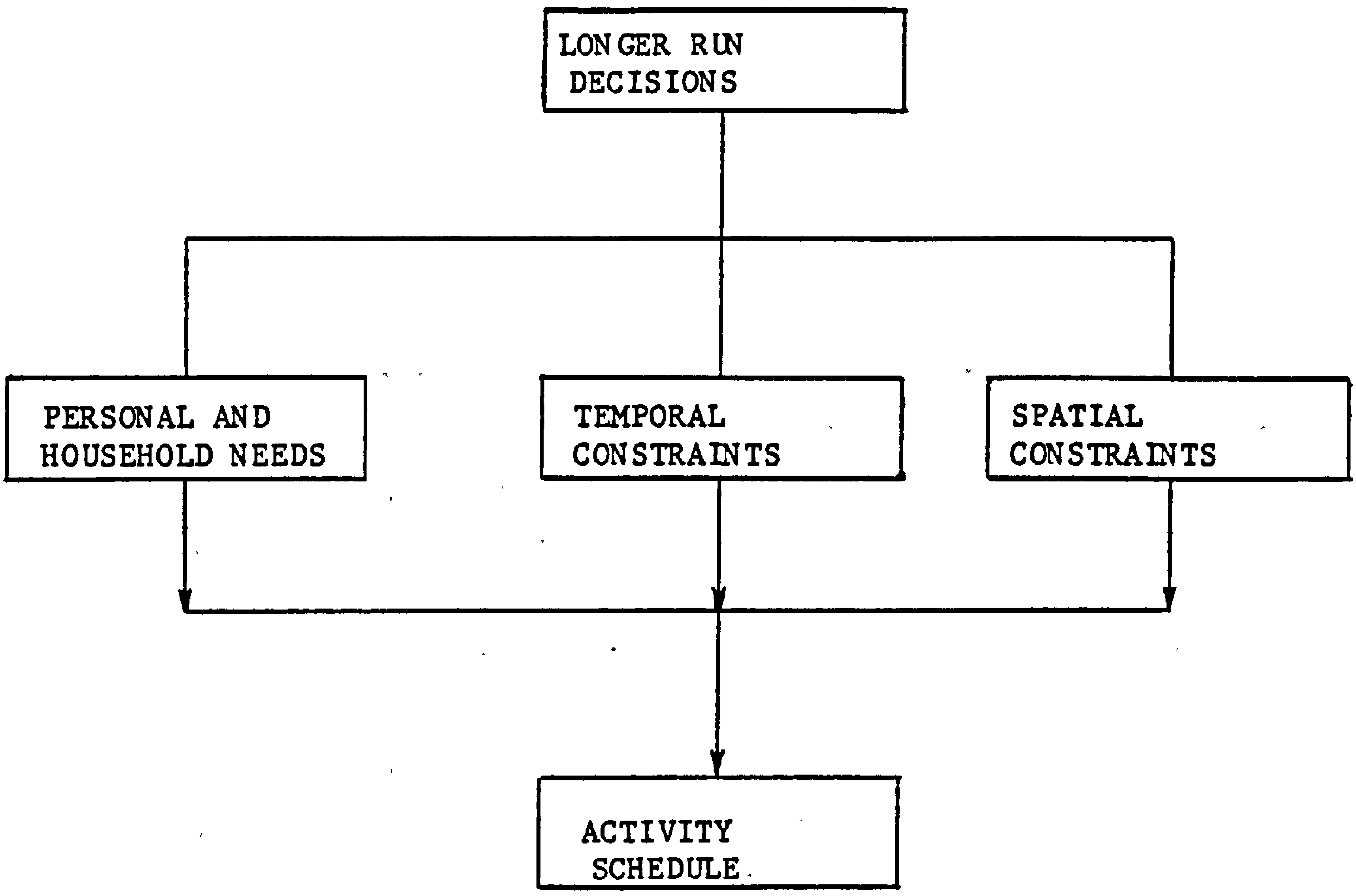


FIGURE 4

Summary of factors influencing activity scheduling

Source: Damm (51)

theory requires information on in-home activities, opening hours of major activities, degree of flexibility in worker's arrival and departure time and non-motorised movements.

Until this data is available activity-based analysis will not play a major role in transportation planning.

3.4 Concepts and Approaches from Consumer Behaviour Theory most Relevant to the Study

3.4.1 The previous section reviewed the theory used to model consumer behaviour. The gravity model, or a similar type of spatial interaction model, is widely used in practise to estimate consumer demand. The model has its origins in central place theory, developed by Christaller(53) & Losch(54), however the empirical evidence does not support the central place concept of choice.(55) One of the major reasons for this is that retail spatial competition introduces monopolistic elements that are absent from aspatial competition as found in economic theory.(56) This means that market area boundaries are less sharply defined as a result of complex travel patterns. Casparis(57) postulated that consumer preferences and income must influence retail patterns and to assume the consumer will always use the nearest store is questionable.

The work of Hubbard(58) also suggests that consumers are likely to bypass the nearest alternative if the extra effort is compensated by better shopping opportunities.(59) This notion was developed by Reilly(60) into a "law of retail gravitation" which subsequently developed into the gravity model. Although based on the initial central place theory framework the gravity model incorporates a retail competition element represented by "size" of store.

3.4.2 The advantage of the gravity model is primarily its convenience which is suited to the strategic planning required for development control. It is also proven and its limitations are well documented. Pankhurst & Roe,[61] in comparing a gravity-type model with a decision-type model, found that the gravity model fitted observed data more closely but its generality was poor and showed sensitivity to lack of precision in the parameter values of the model. They suggested that sub-models be developed from disaggregated data enabling the local values of the model parameters to be determined and input to the gravity model.

3.4.3 The emergence of probabilistic theory applied to retail choice was primarily due to Huff[38] who argued that consumers may visit more than one store and the probability of visiting a particular store is equal to the ratio of the utility of that store to the sum of the utilities of all stores considered by consumers. The Huff model (see para. 3.3.2) was the first to suggest that market areas were complex, continuous and probabilistic rather than the non-overlapping geometrical areas of central place theory. The calibration process involves dividing the market area into zones based on residential characteristics and traffic patterns and selecting, randomly, a number of households from each zone. These households are then surveyed to determine for each zone the proportion of store visits made to a particular store. Most empirical studies support the usefulness of this approach[62,63,64] however the accuracy is not good for predicting trips to individual stores. Stanley & Sewall[65] incorporated a store image utility function in the model and improved its performance in this respect. However although the probabilistic framework and zoning method based on area characteristics are useful to this study the weakness of individual store trip prediction is important to development control.

3.4.4 Nakanishi & Cooper[66] have developed a more general spatial choice model called the Multiplicative Competitive Interaction Model (MCI). They considered store characteristics as well as store attractiveness and estimated the model parameters by log transformation and least-squares procedures. A number of retail companies have employed this method[67] but its main application is in site selection.

The multinomial logit and probit models, mentioned earlier suggest a good approximation to aggregate choice data but are again, at present, mainly applied to market information and simulation experiments.[68] More research is required to develop these models as retail choice models.

3.4.5 The problems of the revealed preference models outlined above, and with respect to this study, are twofold :

a) they assume consumer utility functions to be compensatory, i.e. individuals trade-off low levels of one attribute with high levels of another. Recker & Schuler[69] found that this compensatory assumption did not predict shopping store choice well.

b) they are context dependent i.e. the estimated parameters reflect the characteristics of the area. Rushton[70] found that these area characteristics influenced the utility of the alternatives. Also a number of studies[58] have shown the distance decay parameter to be highly dependent on the characteristics of the spatial structure. The implication is that consumers consider not only the distance to a particular store but the relative distances to other store alternatives. Therefore, depending on the area, consumers may add a differential weighting to the impact of distance on store choice.

Continuing with this latter point Ghosh[71] found that inclusion of the ratio of distances to the closest and farthest stores from each origin improved the revealed preference model's predictive ability. Hubbard[72] found that the socio-economic characteristics of the area affected the spatial structure and this implies that spatial choice models should be calibrated for different segments of the population, or disaggregate models should be used to directly assess the effect of socio-economic characteristics on store choice. The disadvantage of the latter approach is that it requires a large amount of data. However if a generalised form of disaggregate model could be developed linking the socio-economic characteristics of the area to store usage then this would negate this point.

3.4.6 The final group of models discussed in section 3.3 was attitudinal models. Their advantage is that they overcome the problems of context dependency, discussed with respect to revealed preferenced models, because they estimate consumer utility functions from simulated choice data. They do not, therefore, rely on past choices to reveal the utility function and the estimated weights do not reflect the effect of spatial structures. However these models have problems of definition in that the hypothetical store configurations must reflect the entire spectrum of possible values for a store attribute and they must also be realistic to ensure a meaningful response.[73] The design of the questionnaire is also critical.

An important assertion, in this context, is made by Louviere & Meyer[50] who found that simple relationships exist between attitudes and trip behaviour. There are, however, major problems with these models with respect to destination choice and there is little evidence of major improvements, at the present time, to the conventional household or person-based models.[74]

3.4.7 Present practise in the strategic transportation planning control of large foodstores is based on aggregate models, either an individual estimation of trip generation based on floor area or a more general gravity-type model distributing trips to all stores but based on store measures such as floor area and number of parking spaces. This is because these methods are convenient, economic and well-tried. Even though they have shortcomings these are well documented and can be allowed for in the decision-making process. The reluctance to change from this situation to a more disaggregate approach is significant. Confronted with a choice between an imperfect but understood approach to another which is potentially superior but has not stood the test of time, the transportation planner will not change the status quo. There is a need therefore to develop a method which can be applied within the efficiency and economic constraints of practise but which gives the planner a more accurate prediction within which the decision can be made.

3.4.8 The previous chapter showed the unsatisfactory nature of individual store trip prediction based on floor area. This chapter has shown that the traditional gravity-type shopping model can be calibrated to fit observed data satisfactorily but the nature of the trip generation and subsequent parameter calibration means the model is context dependent. To calibrate this for every planning application would be costly in time and money and still relies on aggregate prediction techniques.

Craig, Ghosh & McLaffery[59] suggested incorporating some form of disaggregate consumer behaviour model into an aggregate model. That is to use the aggregate model to distribute trips to individual stores but improve the trip prediction and generality of the model by using a disaggregate model. This requires a study of consumer behaviour at the origin end of the trip, household-based as opposed to store-based. The household being the preferred unit for shopping activity rather than the individual because of the nature of the activity.[75]

3.4.9 The aim of this study is to identify and develop a disaggreagte model that will predict private-car shopping trips to large stores and will interface with the current gravity-type distribution model used in practise. This implies a split between the generation of these trips, at a disaggregate level, and the distribution of these trips at the aggregate level. Thus it is assumed that further work, outwith this thesis, may be necessary on the distribution model replacing the gravity-type approach with some improved representation. This then is viewed as a two stage process, this study seeking to develop a disaggregate trip generation model which can initially be linked to the conventional gravity model but can be further developed, at a later stage, into a more suitable distribution model.

3.4.10 The probabilistic and attitudinal models can however contribute to the development of this model. The zone framework, based on residential characteristics, used in the probabilistic model is a useful basis when linked to Hubbard's[59] work on the socio-economic characteristics of an area and their influence on household trips. Revealed preference models show a link between spatial and consumer behaviour and Louviere & Meyer[50] established a link between consumer judgement and perception and the characteristics of an area. Pirie[76] showed that spatial preference is linked to spatial behaviour and may be modelled from observing such behaviour. The outcome of store choice can either be viewed as a reflection of motivation and household values or a reflection of the constraints of the environment and personal circumstances, that is spatial choice can be discovered by questionnaires designed to elicit preferences or by studying overt behaviour.[77] The latter approach is suited to the argument being developed in this chapter and indicates, given the links established between the socio-economic characteristics of an area and spatial choice, that there is a relationship between the behaviour of shoppers and their area characteristics. Thus by studying their overt behaviour and comparing this with the area characteristics the nature of this relationship can be established and once established can be used to predict private-car trips to foodstores at a disaggregate level. The generality of the relationship, if established, would also require investigation.

3.5 Development of Factors Relevant to the Establishment of a Disaggregated Trip Generation Model

3.5.1 The demand to use large foodstores can be conceptualised in many ways but is generally seen to comprise three elements :

a) the needs of the household with respect to the activity
b) the temporal constraints on the household
c) the spatial constraints on the household

This was discussed under activity modelling, and the work of Damm,[51] earlier in the chapter. If it is true that consumer behaviour can be predicted from the area characteristics then it can be postulated that the needs of the household, with respect to bulk-buying of food, can be predicted from the household characteristics. This also seems intuitively reasonable as a large, high income family, for example, would be more likely to bulk-buy their food than an aged, single person of low income. The temporal constraints consist of availability of transport and the availability of the person, or persons, to carry out the shopping. Benwell & White[78] have called this term "personal accessibility". The spatial constraints consist of the opportunities to carry out this type of shopping, that is the distribution of shops with respect to the particular household. The definition of this spatial accessibility can contain store attraction terms as well as a distance term. The latter two factors are discussed in the next chapter on accessibility.

3.5.2 The first term, which refers to the needs of the household with respect to bulk-buying of food, consists of household characteristics. If it is assumed that only car-owning households are studied and that given the need to bulk-buy the household will reallocate its use of the household car, or cars, to make that possible and given that the area being studied has a number of suitable shops which provide opportunities to bulk-buy food, then the demand is reduced to the characteristics of the household and the personal accessibility of the shopper, or shoppers, to carry out the trip. Since this study aims to predict private-car trips to large stores and Holman & Wilson[79] showed that it is reasonable, given the household decision to use these stores, that a car can be made available either during the day or in the evening, or at the weekend, the first two assumptions are acceptable. The second assumption is true of all cities in Britain and indeed most large towns and these are the areas where most planning decisions will be required. It may be further argued that the shopper, or shoppers, can also allocate time so that the shopping is carried out, although certain characteristics such as employment and family structure will limit the time available.

3.5.3 The above postulates that the demand can be predicted, given these assumptions, using the characteristics of the household with respect to the personal availability of the shopper, or shoppers. It can also be viewed in terms of the aim to develop a disaggregate trip generation model based on household characteristics linked to a conventional gravity-type distribution model. Thus the generation is split from the distribution, the latter being distributed primarily with respect to the spatial distribution of suitable stores.

3.5.4 This introduces the effect of competition between stores which can affect the choice of store with respect to the consumer. This is the difference between the prediction of trips to individual stores based on their floor area and using a shopping model whether aggregate or disaggregate. These models attempt to simulate the competitive framework the consumer perceives from the basis of size of store, as used in the gravity model, to the discovery of attitudes and beliefs of the individual consumer, as used in behavioural/attitudinal modelling. If the distribution of trips is separated from their generation then competition must be kept constant in order to establish that the relationship is between household characteristics and store usage. This implies that the households to be studied must have the same opportunities open to them so that the differences in their use of the stores is attributable to the differences in household characteristics. Thus the households must be spatially together. Having established a relationship between household characteristics and store usage in one group of households this can be compared with relationships in other groups of households. If the relationship is the same then the spatial separation, and the change in spatial distances to stores, has not altered the relationship and a general disaggregate trip generation model can be developed using the household characteristics of an area. If there is a difference then either a competition variable could be added to accommodate the difference or a relationship based on household characteristics alone cannot be achieved.

3.5.5 One of the prime factors affecting the allocation of time within a household, as mentioned above, is employment structure. This is of considerable interest to researchers charting the shift of women into the workforce.[80,81] Nichols & Metzen[82] showed that the woman continues in her role of principle shopper even though her work status changes her time allocation.

3.5.6 The age structure and family size of the household also affects the activity pattern of the household.[83,84] It relates to employment which in turn relates to the income level of the household. The income level not only makes bulk-buying easier but can be used to increase the time available by purchasing the time of others to perform certain tasks. Most empirical studies of shopping behaviour include income as a variable.[85,86] Related to income is social class which is widely used as a predictor of retail usage.[87] Potter[88] showed that social class was related to the use of retail stores.

3.5.7 The general factors therefore, from past studies, which influence the shopping activity pattern of the household are the household and employment structures, income and social grouping. The ages and size of the household will determine the food requirement and the income and employment structure of the household will determine the ability to meet that demand. The social grouping of the household relates to the method of carrying out the shopping to meet that demand.[88]

3.5.8 This is supported by Neale & Hutchinson who related shopping activity to household structure, income, car ownership and two walking variables specific to their study.[85] Dix[86] identified income, household structure and life-cycle, which related to employment, as the important household characteristics with respect to household trips. Thus in general three effects influence the shopping pattern of the household : household structure, employment structure and income and social class.

3.6 Development of Variables Relevant to the Establishment of a Disaggregated Trip Generation Model

3.6.1 Car Ownership

This study relates to car-owning households however the level of car ownership within the household will improve the personal accessibility of the shopper, or shoppers. The Eastleigh Carrefour study[89] showed that car ownership rises with household size and that car ownership among large foodstore users is above average (see Table 6). The study also concluded that car availability is not critical since, given the decision to use the store, the household will reallocate their time to enable the shopping trip to take place. Garland showed that a strong relationship exists between car ownership and employment and income and this is supported by the Coventry shopping studies.[33] The Eastleigh Carrefour study[89] identified level of car ownership and household size as the best predictors of private-car trips to large stores.

3.6.2 Income

A number of studies have established a relationship between income and shopping usage.[90,91,92] It is

Household Size	Sample Size (No. of Households)	Households with own car or van %
1 person	657	21
2 persons	1178	60
3 persons	631	75
4 persons	681	81
5 or more	460	77

Source : Department of the Environment

TABLE 6

The Relationship between Car Ownership and Household Size obviously true that higher income groups have a greater disposable income and a greater opportunity to bulk-purchase if they so desire. Again, the Eastleigh Carrefour study showed the high incidence of high-income households using the store.[89]

3.6.3 Employment Structure

The number of people employed in a household affects the income level and the time allocation of the household. One of the advantages of the bulk-purchase of food at one centre is the time savings which are important in a high employment household and less so in other households with a lower employment level. Ochojna & Macbriar[75] showed that employment is a powerful predictor of shopping trips and this is supported by Garland & Neale & Hutchinson.[33,85]

3.6.4 Social Grouping

Retail studies exploring the effect of socio-economic variables on shopping trips have shown that a relationship exists between shopping usage and social grouping. These studies also show a relationship between store choice and social grouping.[93,94,95] Wasson[96] argues that social grouping is a good segregation base for types of shopping and Schaninger[97] and Hirisch & Peters[98] show that it is a predictor of food shopping.

3.6.5 Household Structure

It has already been intuitively argued that larger families are more likely to bulk-buy than smaller families. This is given substance by the Eastleigh, Carrefour study[89] and Garland[33] showed that it was a stronger predictor of shopping trips than income. The Transport & Road Research Laboratory concluded, on their work at Reading[99], that household size was a major predictor of trip rate.

3.6.6 House Type, Freezer Ownership and Number of Licenses in the Household

There are three other variables which it is proposed to include i.e. house type, freezer ownership and number of licences in the household. There is no rigorous support for these variables in the literature but they are related to this study and should be included in the preliminary analysis.

House type is related to social grouping and, if significant in predicting store trips, is available on census data. Freezer ownership is related to storage of food and hence the bulk-buying of food. Without a freezer an additional constraint is placed on the consumer. The Eastleigh Carrefour study[89] showed that store users were more likely to own a freezer than not.

The number of licenses is related to the personal accessibility of the household and it is argued that it will be positively correlated with store usage since the more people in the household that can drive a car the easier it is for a shopping trip to take place.

3.7 The Variables to be Used and Their Measurement Problems

3.7.1 A common problem in consumer behaviour analysis is the mixing of nominal, ordinal, interval and ratio scale variables, for while parametric statistical analyses can be performed on the latter two it is inappropriate for the former two. (For a fuller explanation of these variable measures see The Analysis of Survey Data - Volume 1 ed. by C.A. O'Muircheartaigh and C. Payne, John Wiley & Sons). This is important to multivariate analysis which relies on the application of parametric statistical techniques. Of the variables discussed above house type and freezer ownership have only nominal scale and social grouping has ordinal scale. This means that only non-parametric methods are permissable for social grouping. The remaining proposed variables, that is income, car ownership, number of licenses, level of employment, age structure and personal accessibility can all be measured in such a way as to give them ratio scale status and enable parametric statistical methods to be employed. The social grouping variable will be measured as the socio-economic grouping of the household member defined as the head of the household.

3.7.2 Income is difficult to measure due to a reluctance to divulge the household income. For this reason it has been omitted in the past. However it is proposed to use income bands to overcome this reluctance and yet still collect the information in a suitable form. Car ownership and number of licenses in the household will be straightforward, the number of cars, or vans, to include all cars the shopper, or shoppers, have access to for shopping. Employment will be the number of days, or half days, employment per week in the household. This means that the measure will have ratio scale status. Age structure could be categorised according to the ages of the household members however it is better to retain a ratio measure and therefore it is proposed to use three numeric variables which will describe the structure. These are the number in the household, the mean age of the household and the standard deviation of the ages. Personal accessibility is discussed in the next chapter.

3.8 Concluding Remarks

3.8.1 This chapter has argued from existing consumer behaviour theory that there is a relationship between the characteristics of a household and the bulk-buying of food for that household. The concept postulated combines an aggregate and disaggregate approach to achieve a strategic planning model for development control of large foodstores based on a conventional gravity-type model with the generation term calibrated from a disaggregate model based on household characteristics. Thus it is proposed to split the generation and distribution stages of analysis. This thesis is concerned with the development of the disaggregate trip generation model.

3.8.2 In order to achieve an understanding of the relationship between household characteristics and store usage the effect of competition must be removed. This will be achieved by grouping households together and comparing the relationships developed between groups; the effect of spatial accessibility can then be assessed.

3.8.3 The next chapter discusses in detail the nature and effect of both personal and spatial accessibility with respect to shopping and complements this chapter on consumer behaviour. The research objectives and conceptual framework can then be developed in the following chapter.

CHAPTER 4

THE ACCESSIBILITY OF LARGE RETAIL FOODSTORES

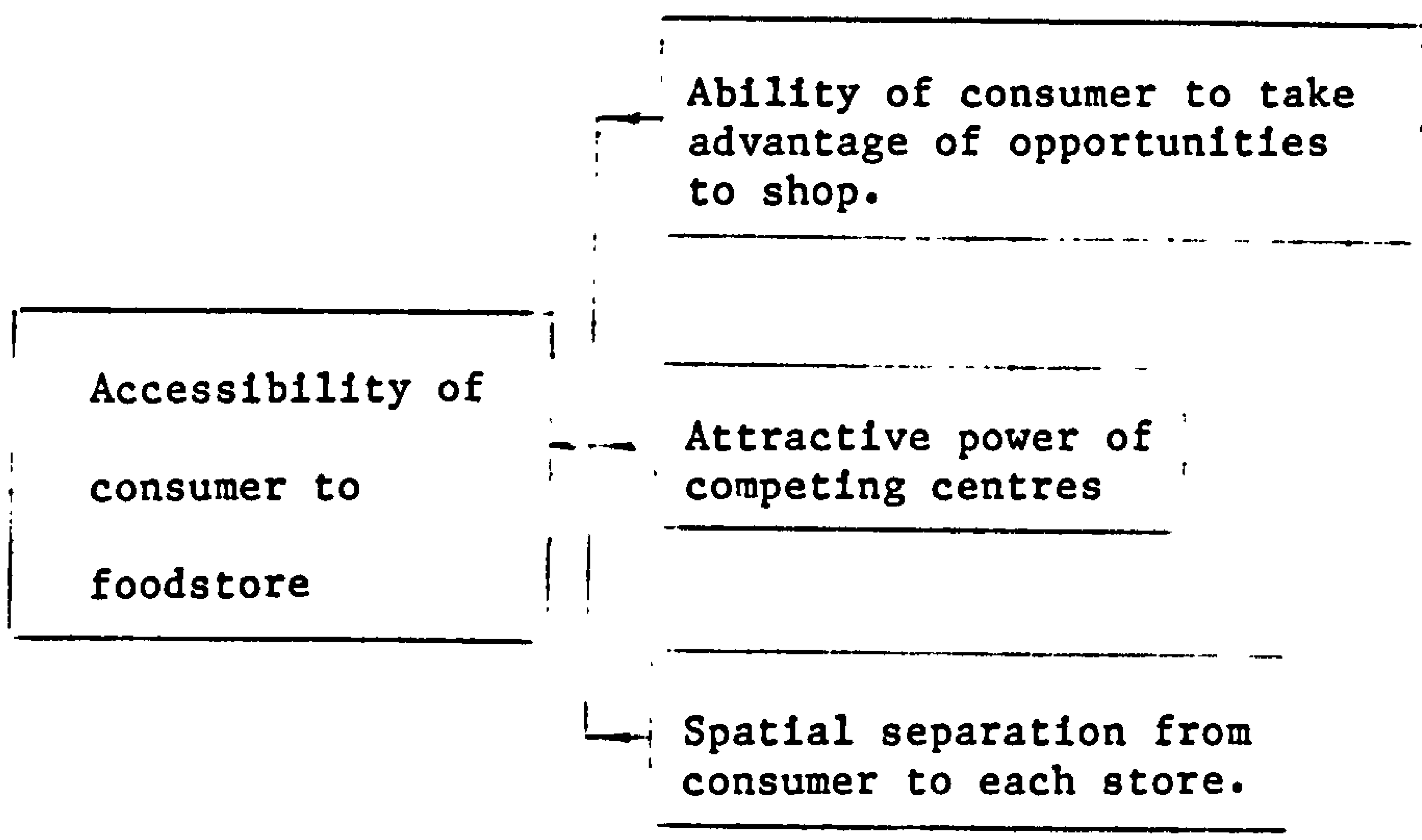
4.1 Introduction

This chapter initially examines the nature of accessibility with respect to bulk-purchase shopping. It is developed as two terms which are called a personal accessibility term and a spatial accessibility term. The former term comprises three factors; the availability of the car, the consumer and the store, and is contained within the trip generation model. The latter term comprises two factors; the attraction of the store over all other stores and the spatial deterrence between the household and the store and is contained within the distribution model. The structure of the trip generation model can be developed as individual variables or as multivariate factors to eliminate multi-collinearity problems between the household variables and the personal accessibility term.

4.2 Application of Current Accessibility Concepts to this Study

4.2.1 The Independent Commission on Transport[100] commented that accessibility is the aim of transport and not mobility, speed or the easing of congestion.[101] Activities cannot exist in isolation; participants require to be transported from their origin to the activity in which they wish to participate. Accessibility therefore, is a measure of the ease of contact with some form of spatially distributed opportunities. It is dependent not only on the locations of opportunities relative to the individual but also on the ease of traversing the spatial separation between the individual and the activity.

4.2.2 A range of aggregate and disaggregate models have been developed to simulate accessibility and a historical review of these models has been carried out by Baxter[102] and Pirie[103]. The basic aggregate models use spatial separation as a direct measure of accessibility whether in terms of distance, time, or cost of the journey. An extension of this concept is to add a term to the model for the attractive power of the activity, with respect to other similar activities. This term introduces a competetive element between activities. Hoggart[104] describes these two factors, the attraction of the activity and the spatial separation between consumer and activity, as travel behaviour and location behaviour. Accessibility therefore is not only the ease of access to an activity but involves the ability of the consumer, relative to his location, to take advantage of the available opportunities. This implies a third term in the model; that of consumer availability. Baxter[102] identified three factors in the measurement of accessibility : mobility, potential and ease of access. These apply to the consumer, the activity and the transport link between the consumer and the activity respectively. Hoggart[104] identified three similar factors but called them consumer circumstances, attractiveness, and deterrence. Doling views accessibility as the link between trip generation and distribution.[105] In terms of consumer accessibility to large foodstores the representation can be seen as three factors, i.e.



This corresponds with the basic store choice mechanism discussed in the previous chapter where these three terms together with the need to shop, represented by the household characteristics, determine store choice. The attraction term and the spatial separation term form part of the distribution of trips, as developed in the previous chapter, whilst the consumer term affects the trip rate at household level. This latter point requires to be substantiated and is discussed in the following section.

4.3 <u>Accessibility and Trip Generation at Household Level</u>

4.3.1 When including an accessibility measure within a trip generation model it is desirable to construct the measure in such a way that changes in the system that affect the accessibility of the household to large foodstores will be accommodated. In most studies to date an accessibility measure based on a Hansen aggregate model has been used.[106,107,108,109] These studies have not shown the accessibility measures to have a significant effect on trip generation. This may have been because the models are unsuited to the purpose. This view is supported by Leake & Hazayyin[110] who showed the necessity of having an accessibility term in the trip generation model. They identified the main requirements of such a term as:

a) it should be easy to understand and logical in expression.

b) it should be easy to formulate and calculate using a minimum input of data and computation time.

c) it should, preferably, utilise data normally collected in transport studies.

4.3.2 Vickerman[111] showed that accessibility has a significant association with variations in trip making and this was specifically shown by Robinson[112] to apply to shopping trips. One of the problems that both Vickerman & Leake encountered was that of collinearity with other household descriptors. The intercorrelations between an accessibility measure and household characteristics can cause difficulties in identifying the effect of the accessibility measure. Vickerman found factor analysis techniques to be useful because of their structuring of the data to produce a simpler structure based on multi-variate factors, however no a priori structure can be used. If stable factors could be identified a basis may be provided on which to build a generalised model of shopping trip generation.

4.4 Disaggregation by Mode and Trip Purpose

4.4.1 Doling[105] showed the need for disaggregation by mode in terms of the fundamental differences between households in levels of mobility and disaggregation by trip purpose in terms of the difficulty in combining measures of accessibility for different types of activity opportunity. Also some opportunities are not accessible to some types of households. This is supported by the work of Leake & Huzayyin[110] and Benwell & White[78], the latter authors showing that the accessibility of certain groups to certain activities varies depending on their car availability and the activity.

4.4.2 This study is by definition disaggregated by mode and trip purpose. The study of shopping trips has the advantage that all households take part in the activity although not all households shop at large foodstores on a weekly, or more infrequent, basis. The study also relates to private-car shopping trips and therefore car availability may influence the frequency of trips. The ability to make a trip by private car at a given time is influenced by the level of household car ownership, the number of drivers within the household and the time allocation priorities of the household.[78] The first two factors can be easily measured.

4.4.3 If the household uses a large store for the bulk-purchasing of food then it must allocate a significant period of time for the activity. Lucarotti[113] developed a measure of perceived availability using a trip or person descriptor by asking directly whether a car was available and Gwilliam & Bannister[114] took account of observed car availability through the interpretation of a travel diary and household information. Benwell & White[78] describe a method of indexing a survey population to enable a disaggregate study of mobility to be undertaken. Unfulfilled transport need was viewed as a product of the interaction between personal car availability and the timing and location of the available activities.

4.4.4 In applying car availability to shopping trip generation the time involvement for a car-borne trip to a large store will mean that normally one trip will be made per third of a day. That is, if the day is split into morning, afternoon and evening sessions it is reasonable to assume that no more than one car-borne shopping trip within a session will take place. Thus for a shopping trip to take place the consumer, the car and the store must be available simultaneously. This is shown in Figure 5. The size of the "accessibility window" within which a car-borne shopping trip can take place will vary according to the household circumstances. The size of the window represents the level of opportunity the household has to carry out this type of activity. Thus it is a measure of the temporal, or personal, accessibility of the household as opposed to the spatial accessibility of the stores relative to the household location. The time that a car and consumer are available will influence duration of the shopping trip and therefore certain opportunities may be outwith that time constraint. The opening times for large foodstores in Britain is uniform; almost all stores opening on a five-day trading cycle, closing on Monday and opening late Thursday and Fridays. This pattern applies to stores in Edinburgh and means that three standard daily sessions can be defined.

4.5 Personal Accessibility within a Trip Generation Model

4.5.1 The personal accessibility of a household, or the shopper within a household, is seen to comprise three factors :

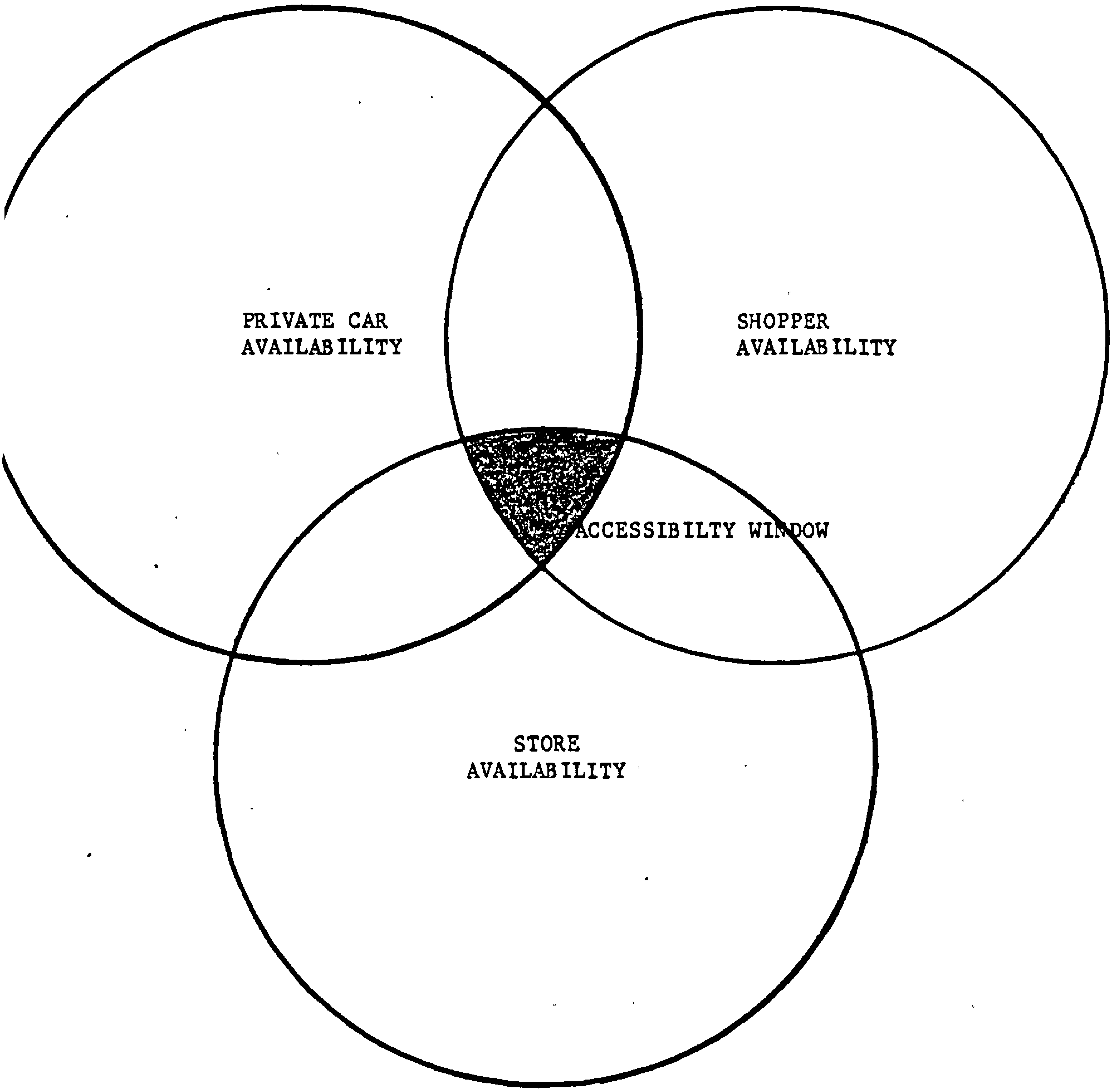


FIGURE 5

The accessibility window of a household to allow a private car, bulk-purchasing trip to a food store to take place.

a) the availability of the car
b) the availability of the shopper
c) the availability of the store

The previous chapter and this chapter have argued that this term should be included within the trip generation model because of its relationship with household variables and its influence on the trip rate of the household. Personal accessibility is a property of the household and the opportunities available to the household and is independent of the trips made. This is shown by Hensher & Stopher[115] and further supports the argument that the trip generation prediction can be separated from the distribution of the trips.

4.6 Spatial Accessibility within a Trip Distribution Model

4.6.1 The spatial accessibility of the household to the shopping opportunities comprises the remaining two factors outlined above, that is the attraction of a store with respect to other stores and the spatial distance between the household and the store. The second factor is measured using journey time to the store, distance to the store, or cost, in terms of fuel and consumer time. Leake & Huzayyin[110] found that journey time was the most effective measure and this is borne out by the author's personal experience.

4.6.2 The distance to a store from a household has an inverse relationship with the usage of that store. The distance also relates to the frequency of use of the store in that the further a store is from the household the less frequent is the trip rate. The duration of stay increases as the frequency decreases.[21,89] Table 7 shows the relationship between frequency of visit and journey time.

Frequency of Visit	Journey Time (%)				
(Sample Size:	0-5 min.	5-10 min.	10-20 min.	20-30 min.	30 + min.
	254	462	775	243	252
Three times per week +	11	3	2	1	-
Two times per week	14	6	4	2	1
Once per week	48	48	47	34	14
Once per fortnight	10	16	17	16	15
Once per month	8	13	15	24	26
Less often	6	9	11	13	21
1st Visit	3	4	5	10	22

Source : Department of the Environment

TABLE 7

The Relationship between Frequency of Visit to a Large Store and Journey Time

4.6.3 The catchment areas of large foodstores follow a uniform pattern in that ninety-five percent of the store's customers come from within a twenty-five minute car-driving time.[24] This is influenced by the characteristics of the catchment area. For example, the Asda, Coatbridge store attracts fifty percent of its custom from within the local district boundary, this approximates to a twenty-five minute car-driving time. The area is densely populated and has a low car ownership level. Expenditure per trip is also affected by location in that the further a household is from the store the more is spent per visit.[89]

4.6.4 The other factor which comprises the spatial accessibility measure is store attraction. This factor represents the competition between stores. It is the attractive power of the store with respect to the other store opportunities. The simplest measure of this factor is store floor area. This can be modified to include retail turnover per square metre.[34,38,116] Consumer expenditure can be used to simulate competition, using the Family Expenditure Survey published annually by the Department of the Environment, but the transferability of the weightings from area to area has not been proven. Trip frequencies can also be used as frequency is proportional to expenditure.

4.6.5 Vickerman[111] argues that store attraction can be represented by certain key store variables weighted by expenditure and including the generalised cost of reaching the store. A further development includes measurement of store attributes. Huff[55], for example, used reputation, amenity value, range of goods, services and prices. Davies[93] developed a scheme of retail quality grading which includes prices, quality of goods, range of goods, window display, shop appearance and degree of specialisation. Downs[117] listed nine similar cognitive categories relating to store attraction. Thus with this measure we have the same choice discussed in the previous chapter relating to the motivation and values of the consumer determining store choice or the constraints of the environment and personal circumstances determining the choice.

4.6.6 The second postulate has been argued in this study but the measures of attraction, listed above, relating to store image should be the subject of further work on the distribution of predicted shopping trips. Thus it is argued that the household makes a decision to bulk-buy its food and this decision can be modelled from the household characteristics and the personal accessibility window of the household. The predicted trips from the households in an area are then distributed to the store opportunities in the area. These opportunities, because of the type of shopping, are easily identified. The distribution model, although not developed in this thesis, should incorporate a spatial accessibility term to reflect the distance from the households to the store and the attraction of one store over another. This term should be in keeping with the aggregate form of the model and the purpose of the model, as shown by Leake and Huzayyin.[110]

4.6.7 Benwell & Seaton[118] incorporated number of shops, retail floor space and retail turnover into an attraction term in an aggregate shopping model of the form,

$$F_{ij} = \frac{k\, W_j}{d_j\, \beta}$$

where F_{ij} = trips from origin i to destination j

W_j = relative attraction of destination j; based on retail floor area; retail turnover and number of shops

d_j = distance by road

β = power function

k = a constant

The concept of relative attraction is well-known. It has been used extensively in environmental assessment where absolute measures are difficult to achieve but comparative measures can be related to known situations. The argument therefore is that the proportional differences between stores is correct and can represent the attraction of one store relative to all other possible stores. In the context of the aggregate distribution model proposed in the previous chapter, this could be initially measured by distance and/or retail floor area using the same argument that was advanced i.e. that this method at the distribution stage has proved a satisfactory model in past studies for the purpose of development control of large stores.

4.7 Concluding Remarks

4.7.1 This chapter has examined the effect of accessibility on the generation and distribution of private-car trips to large foodstores. This is seen as comprising two parts which have been entitled personal accessibility and spatial accessibility. The latter term is made up of two factors; an attraction factor and a spatial deterrence factor. It is argued that personal accessibility relates to the shopping trip rate of the household and should be contained within the trip generation model while spatial accessibility is contained within the distribution model.

4.7.2 The personal accessibility term is subdivided into three factors: the availability of the car, the availability of the household shopper and the availability of the store. The size of the time period when all three coincide is a measure of the personal accessibility of the household to carry out this type of shopping. This concept of shopping accessibility can be combined with the theoretical postulates developed from consumer behaviour to formulate the research objectives and the conceptual framework of the thesis in the following chapter.

CHAPTER 5
DESIGN OF RESEARCH PROGRAMME

5.1 Introduction

The previous chapters on consumer behaviour and accessibility identified variables which affect large foodstore usage. This chapter relates these variables to the research objectives and conceptual framework of this thesis.

The chapter begins by listing four research objectives and explaining the concept of household choice of store as a two-stage process; that of decision to make a trip (generation) and decision to use a particular store (distribution). The effect of competition is then discussed and an explanation of the way the sampling framework keeps competition constant within each surveyed area.

Two model structures are proposed one based on combined variable factors and the other on individual variables. Each model seeks to establish a relationship between store usage and identified household characteristics.

The structure of the dependent variable of store usage is defined, together with the independent variable structure, with respect to the two model concepts and a diagramaatic summary of both models and the conceptual framework is given. The latter diagram shows how each model will be examined at individual area, at means area, and at total area level to establish the level of disaggregation possible within the objective of producing an applicable trip generation model for the development control of large foodstores.

5.2 Research Objectives

5.2.1 The research objectives of the study are as follows :

To develop a trip generation model which predicts the number of private-car shopping trips to large foodstores from a given area using household census data.

To build the model so that it can be developed as a strategic planning tool for the development control of large foodstores.

To examine the model at a disaggregated and aggregated level to confirm, or otherwise, if the relationships established at the disaggregate level can be generalised and to establish the level of generalisation that can be achieved.

To show how the model can be combined with a gravity-type distribution model to build an area-wide model of private-car trips to large foodstores.

5.3 Building the Conceptual Framework

5.3.1 The chapter on consumer behaviour theory highlighted a range of variables that have been shown to correlate with shopping trips. The major influences were found to be employment, household structure, income and SEG. The following chapter on accessibility identified two types of accessibility: personal accessibility and spatial accessibility. The former relates to the availability of the household shopper and car and is to be included in the trip generation model. The latter is to be included in the trip distribution model.

5.3.2 The household choice process identified from these chapters is shown in Figure 6. This shows the basic

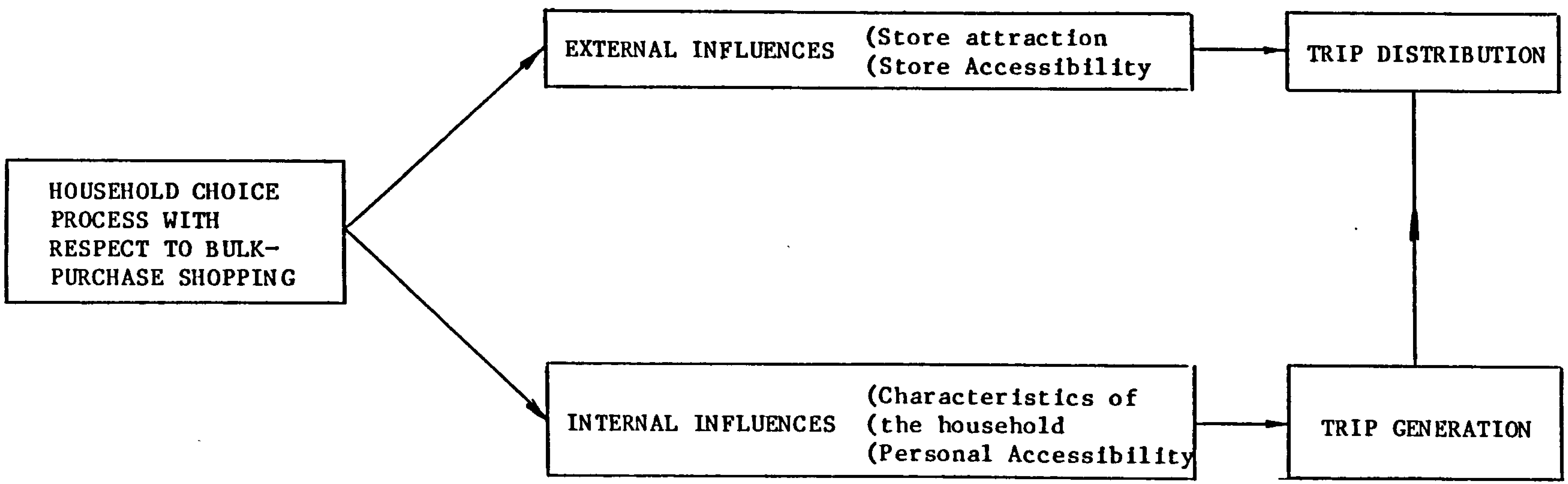


FIGURE 6

Model of the household choice process with respect to bulk-purchase shopping by private car assumption of this study that the generation and distribution of bulk-purchase shopping trips can be modelled separately; the generation of trips being modelled from household characteristics and the distribution being modelled by standard gravity-model techniques. In other words the decision to bulk-purchase food can be predicted from household characteristics, based on census data, and once the decision has been made the household chooses from the store opportunities available.

5.3.3 The basis of this approach is the established relationships between household characteristics and store trips as developed in Chapter 3. Downs(117), Bender(119), Brown & Fisk(120) and Hansen & Deutsher(121) discovered that shoppers tend to overcome a dislike of the large store environment in order to achieve time and/or cost savings and this implies that the characteristics of the household govern the shopping behaviour of the household.

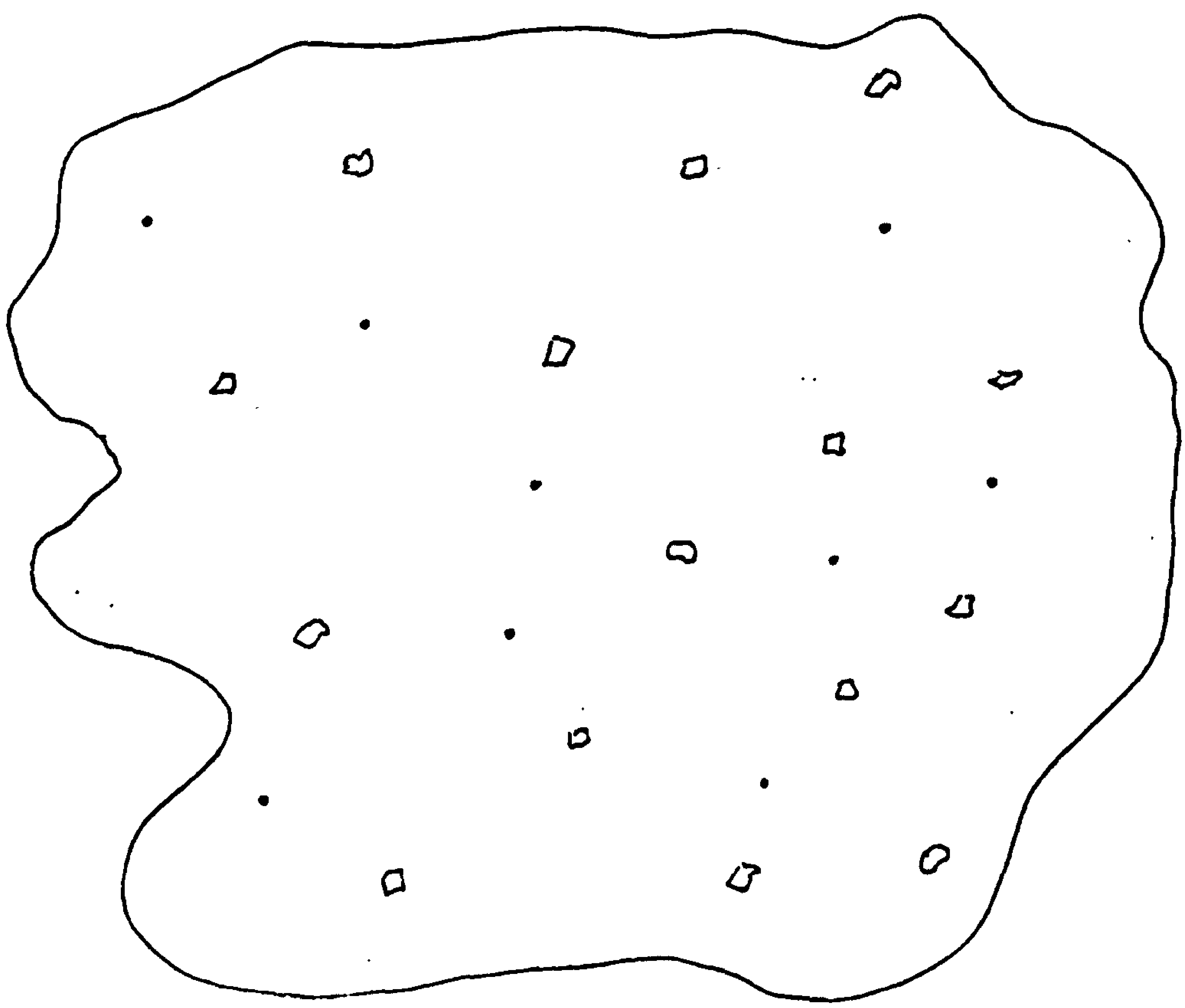
5.3.4 The shopping behaviour of the household may be measured using the revealed behaviour of the household and the characteristics of the household. If this can be acheived the household trips can be aggregated to a zonal level, which corresponds to transportation zones previously defined by the Regional Authority, and distributed to the stores in the study area i.e. within the Edinburgh City boundary. The model could then be calibrated to match the individual store arrival patterns. Thus the proposed method uses the standard gravity-type distribution model improved by the addition of a disaggregate generation model developed within this thesis.

5.4 The Effect of Competition

5.4.1 The consumer choice relating to the bulk-purchase of food is viewed as two distinct elements. One of these elements, the distribution of trips, comprises the attraction of the store with respect to other stores and the spatial accessibility of the store. Each store operates within a competitive framework and the effect of ease of access and store attraction, with respect to the competitive framework, will determine the turnover of the store. Thus competition has a major effect on store usage. To investigate the relationship between use of these stores and household characteristics the effect of competition must be eliminated. The previous chapter proposed that the household sample would comprise groups of randomly selected households, so that within each group the households would have equal store opportunities. The within-area relationships between household characteristics and store usage can be compared with between-area relationships and if randomly sampled, with the aggregate grouping of all household areas. Figure 7 shows this sampling framework.

In the latter two cases, that is between-areas and aggregated areas, the competition effect is no longer constant because of the different spatial locations of the areas. This will require an additional spatial accessibility term to be added to the independent variables.

5.4.2 The conceptual framework showing development of the aggregated household data and the sub-area household data is shown in Figure 8. Each sub-area will have a model corresponding to its usage pattern and the comparison of each sub-area model may provide a general trip generation model. Equally by grouping the data together a second generalised model may also be developed. This latter option may be developed from individual households or from sub-area mean values. The calibrated model for the study area would enable the effect of a new store to be evaluated and hence its maximisation of use within an established area.



Key : ⌂ - groups of households

. - foodstore

_ - study area boundary

FIGURE 7

Theoretical study framework showing groups of households and store locations

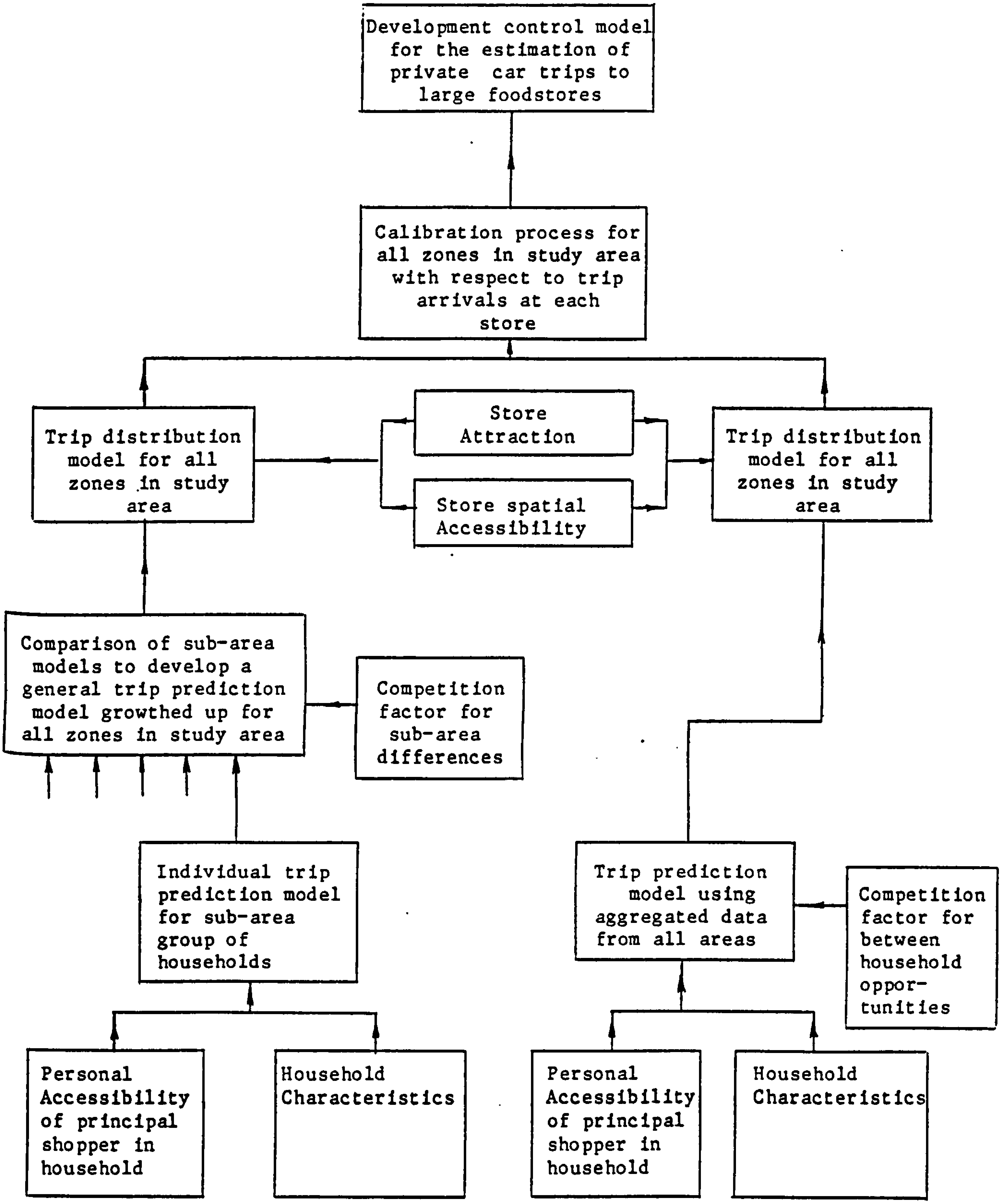


FIGURE 8

Conceptual framework for model development based on sub-area models or aggregated data model

The purpose of the analysis therefore is to explore and develop the relationship between store use and household characteristics at sub-area and area level, developing an understanding of these relationships.

5.5 The Definition of Store Usage

5.5.1 Store usage involves three elements which are inter-related; expenditure, duration of stay and frequency of visit. If a household decides to use a large store for bulk-purchase of food and fixes, by decision or default, the level of expenditure it can afford, this will influence the pattern of usage of the store. For a given level of expenditure a household may choose to spend less and visit more frequently or decrease the frequency and spend more at each visit. This dependent variable structure is shown in Figure 9.

5.5.2 The inclusion of the total shopping budget is to show the bulk-buying expenditure relative to the total shopping budget of the household. This provides a relative budget figure which can be used in the analysis in addition to the absolute bulk-buying expenditure.

5.5.3 The household usage pattern of a store is influenced by the household accessibility window, as defined in Chapter 4, the income level of the household and the needs of the household. Two of the three usage variables will define the third variable. The frequency of visit will determine the arrival rate at a store which will affect road capacity and associated factors such as accident rate and environmental intrusion. The duration of stay will affect the size of car park required and the expenditure level is of interest to the physical planner and developer.

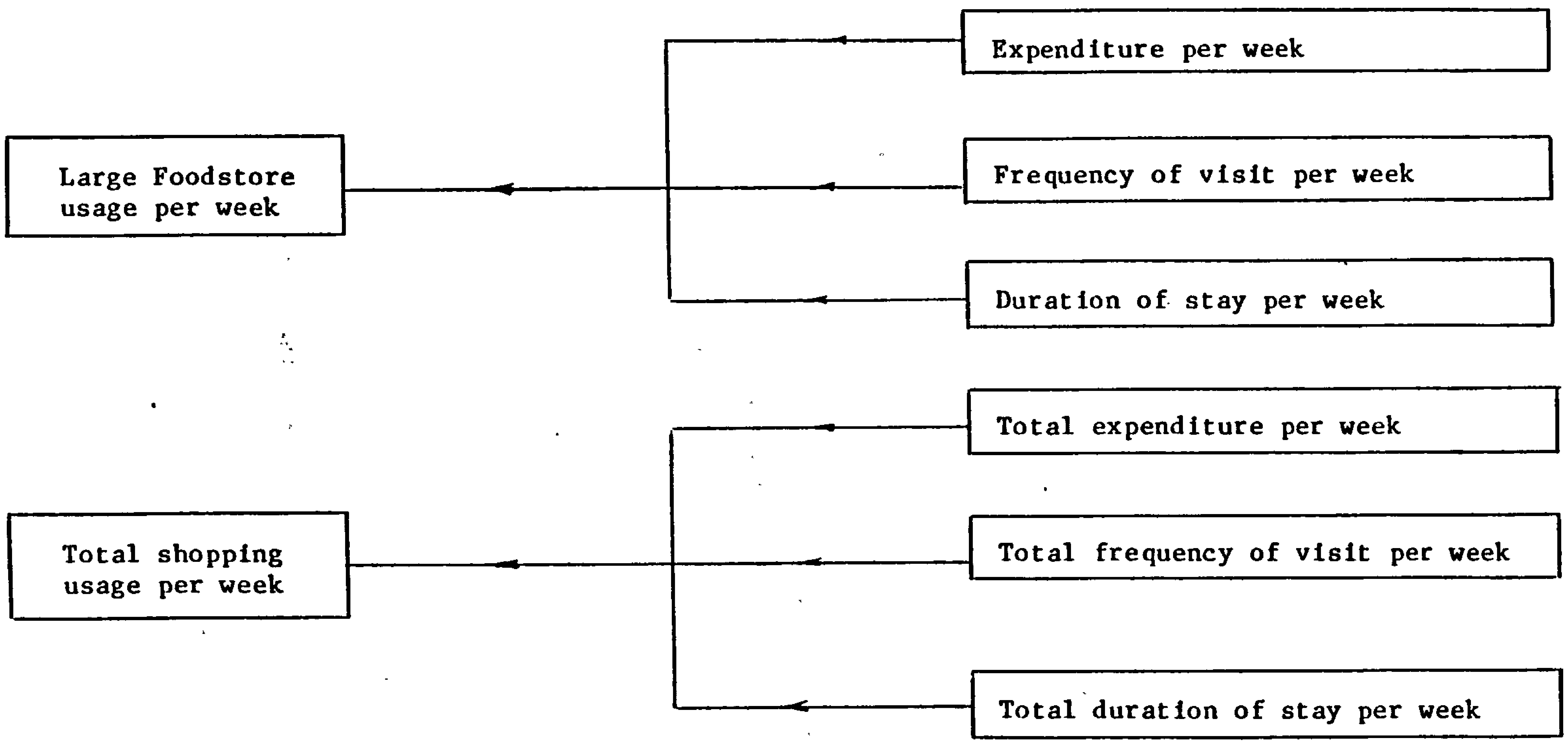


FIGURE 9

Dependent variable structure

5.5.4 It may be that because of the inter-relation of the two sets of three dependent variables a combined usage index is required to model the usage. The disadvantage in the combined usage index is the difficulty of application once the model is developed whereas if the three dependent store variables are kept separate the trip rate and duration of stay can be used to predict the arrival pattern and car parking requirements. The analysis will examine both of these options.

5.5.5 In examining the relationships between household characteristics and store usage the households who use and those who do not use these stores for bulk-purchase shopping by private-car will be included. It is also assumed that only food and general shopping will be included in the survey and that minor shopping trips will be excluded. Major purchases of furniture, clothing, etc., will bias the results relating to the bulk-purchase of food and minor purchases, such as newspapers, are assumed to be insignificant in relation to the household shopping budget. The dependent variables are related to a weekly rate, this being the smallest timescale for bulk-purchase shopping by private car. This means that a monthly trip-rate would be represented by 0.25 trips per week. The duration of stay will be in hours per week and the expenditure in pounds sterling per week on the same weekly basis as trip-rate.

5.6 The Structure of the Independent Variables

5.6.1 In Chapter 3 the major effects on household shopping activity related to the three broad areas of household structure, employment and lifestyle; the latter term comprising income and SEG. This is diagramatically represented in Figure 10. Within each of these three areas are household variables which, in the main, can be obtained from census data. The independent variable

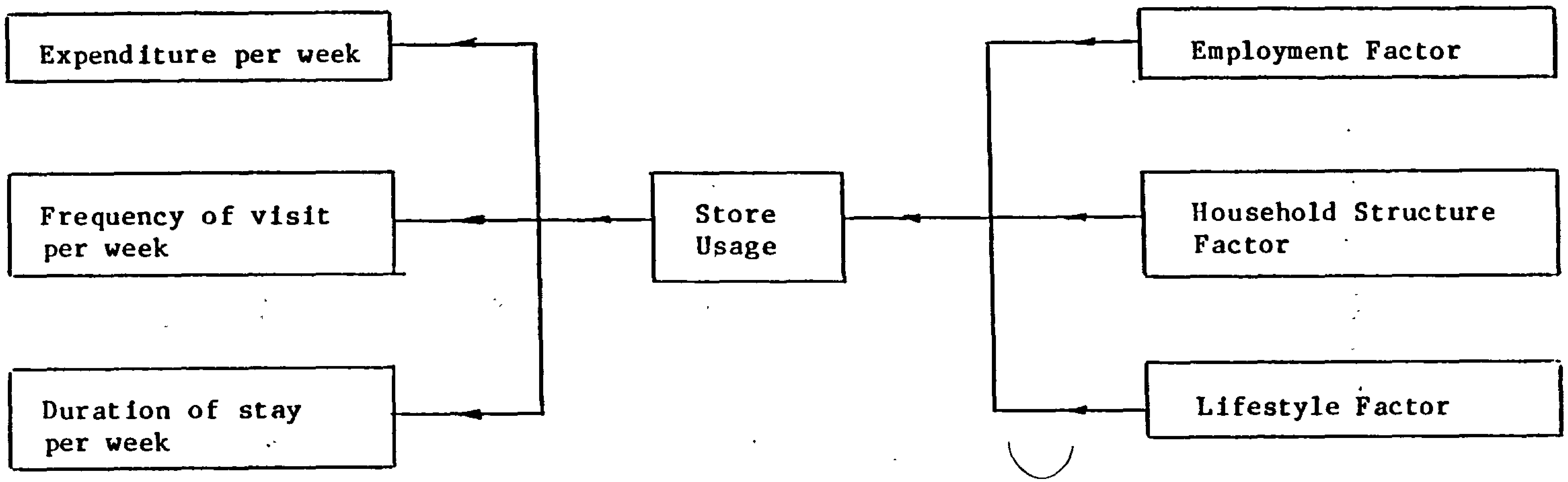


FIGURE 10

Structure of dependent and independent variables structure is to be modelled in two ways; either as individual variables or as factor variables which represent an underlying data structure and are composed of a weighted variable grouping. This corresponds to the optional structure of the dependent variables and again both models will be examined in the analysis. The factor variables will eliminate multicollinearity problems, if these are encountered using individual variables.

5.7 Choice of Independent Variables within each Area and their Indexing

5.7.1 The Household Structure Factor

The size and structure of a household has a major influence on the use of large foodstores. This was shown in Chapter 3 and is confirmed by Garland[33], Ochojna & Macbriar[75] and the Transport and Road Research Laboratory[89]. It is related to car ownership and income and affects the personal accessibility window of the household.[83,84] Census data on household size are readily available and it is proposed to measure it in terms of the number of people in the household, the mean age of the household and the standard deviation of the household ages. The latter two variables give the age profile of the household and are numerical descriptions thus avoiding a category-based classification. Each household will therefore have three variables describing the structure: the number in the household, the mean age of the household and the standard deviation of household ages.

5.7.2 The Employment Factor

The employment status of the household also affects the personal accessibility of the household, determines the SEG of the head of the household and is related to the income level of the household.[93,94,95] There is an inverse relationship between SEG and the number of days members of the household are employed; as SEG rises the number of days employed decreases.[95] This will have a direct effect on the availability, and hence personal accessibility, of the household shopper, or shoppers. It is proposed therefore to include three variables within this factor: the number of half days employed per week, the SEG of the head of the household and the personal accessibility of the principal shopper in the household. It is assumed the principal shopper can be identified and this assumption will be tested in a pilot survey. The measurement of SEG is category-based. The standard classification system is used, as shown in Appendix B, with Group 17 including the retired and unemployed.

5.7.3 The Lifestyle Factor

Income, as discussed in Chapter 3, has an important influence on the shopping behaviour of the household and influences the lifestyle of the household.[52] The measurement of income has proved difficult in past studies, and surrogate variables have been included to represent its effect,[51] but it is proposed to use income bands to overcome consumer reluctance. These bands relate to the gross annual income of the household.

In addition to income it is proposed to add four other dependent variables. These are number of cars in the household, number of license holders in the household, freezer ownership and house type. The reasons for their inclusion have been argued in Chapter 3.

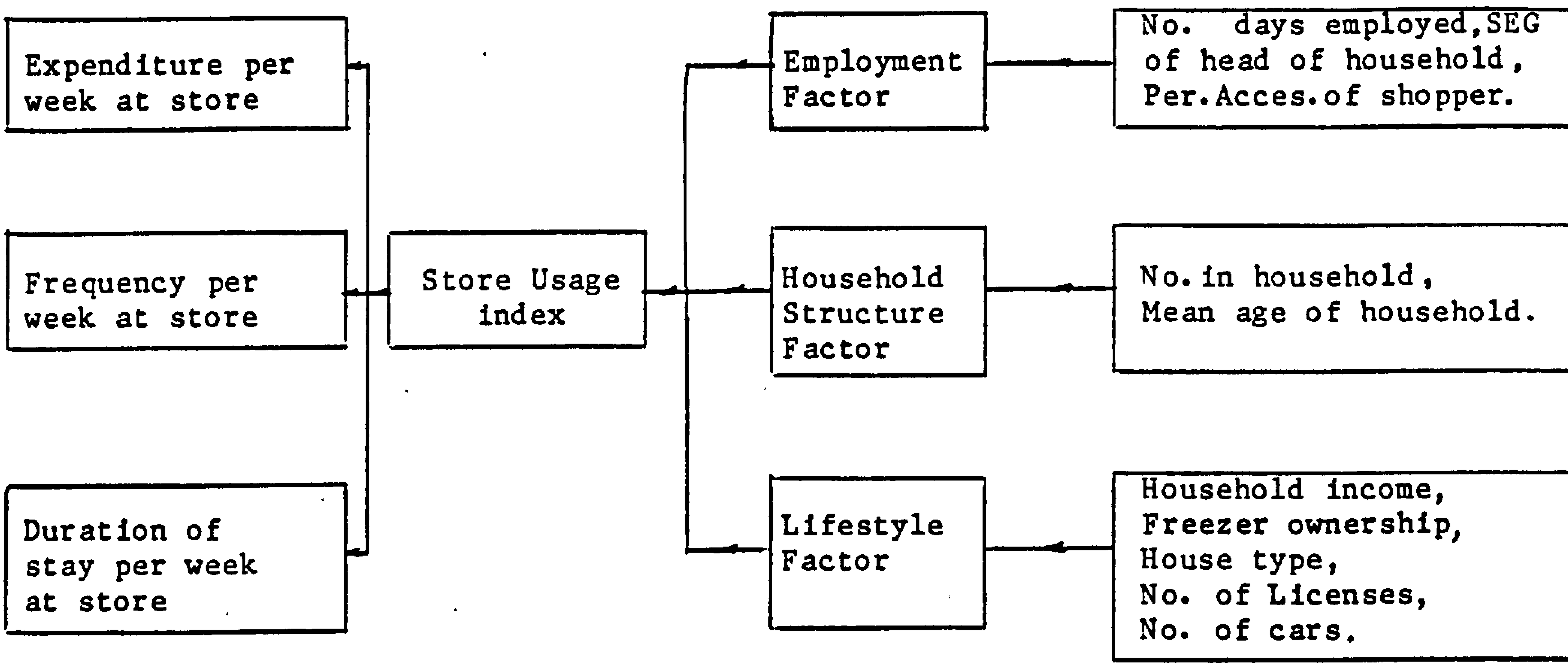
The number of cars and number of licenses in the household affect car availability and hence the personal accessibility of the principal shopper. As discussed in Chapter 3, this does not have a dramatic effect on shopping behaviour since the household arranges its time allocation for shopping around the availability of the car. The number of cars and number of licenses however can provide greater opportunities to shop and in this way may affect the shopping pattern of the household. They are related to household income.

Freezer ownership is also related to income. The Eastleigh, Carrefour[52] study showed that households with freezers were more likely to use a large store for shopping. This variable cannot be abstracted from census data but it will be included in the preliminary analysis.

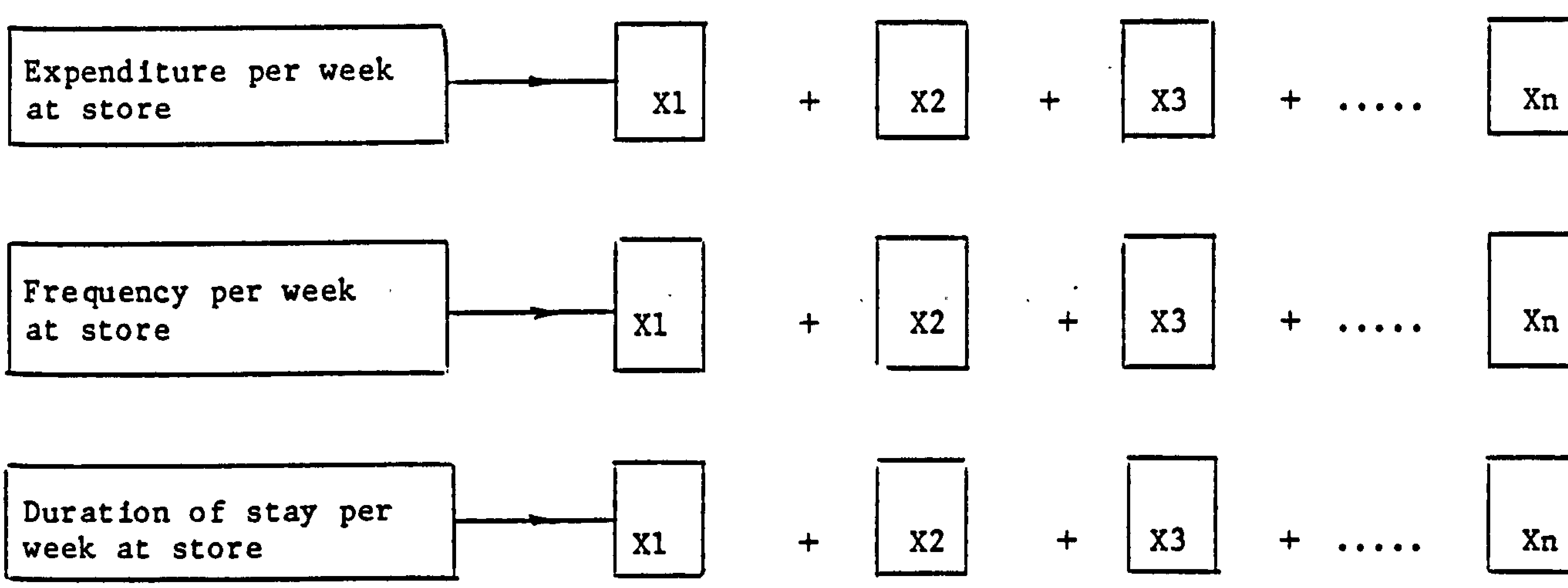
The fourth variable, house type, again relates to the income level of the household. It is a social indicator but its inclusion may be rendered void because of the sampling framework; that is, certain areas may have little variation in housing type. Its effect may be significant when studying between-area relationships.

5.8 The Structure of the Variables Chosen

5.8.1 It is proposed that the dependent variables be divided into two groups of three, each group consisting of an expenditure, frequency of visit and duration of stay variable. One group relates to bulk-purchase shopping and the other to total household shopping. In addition, the variables are to be examined using two model forms. These are shown in Figure 11. One model examines the variables as a combined usage index and the other as individual variables. The latter enables submodels to be developed which will predict expenditure, frequency of visit and duration of stay variables separately for a given area. The former, using factor analysis to identify the underlying data structure, produces a usage index which can be related to intensity of use from a given area. The usage index will be difficult to apply in practise but may



MODEL 1



MODEL 2

FIGURE 11

Two models of the conceptual structure of independent and dependent variables be the only alternative if multicollinearity problems seriously affect the individual variable model.

5.8.2 The independent variable structure is similar to the above and is represented in Figure 11. The same comments apply to the two models.

5.9 The Summarised Conceptual Frameowrk

The summarised conceptual framework is shown in Figure 12. The analysis will examine the relationship between store usage and household characteristics within zones, between zones and with the zones aggregated. The investigative comparison of the relationships established at these levels will determine the degree of generalisation possible with a view to establishing a trip generation model. If established the form of model can be applied at transportation zone level predicting the number of store trips generated within a zone. This will enable the calibration model to be calculated with an accuracy based on the local area and hence enable a more accurate distribution of trips to stores in the area. The following chapters deal with the collection and analysis of data and their application to the research objectives and conceptual framework discussed in this chapter.

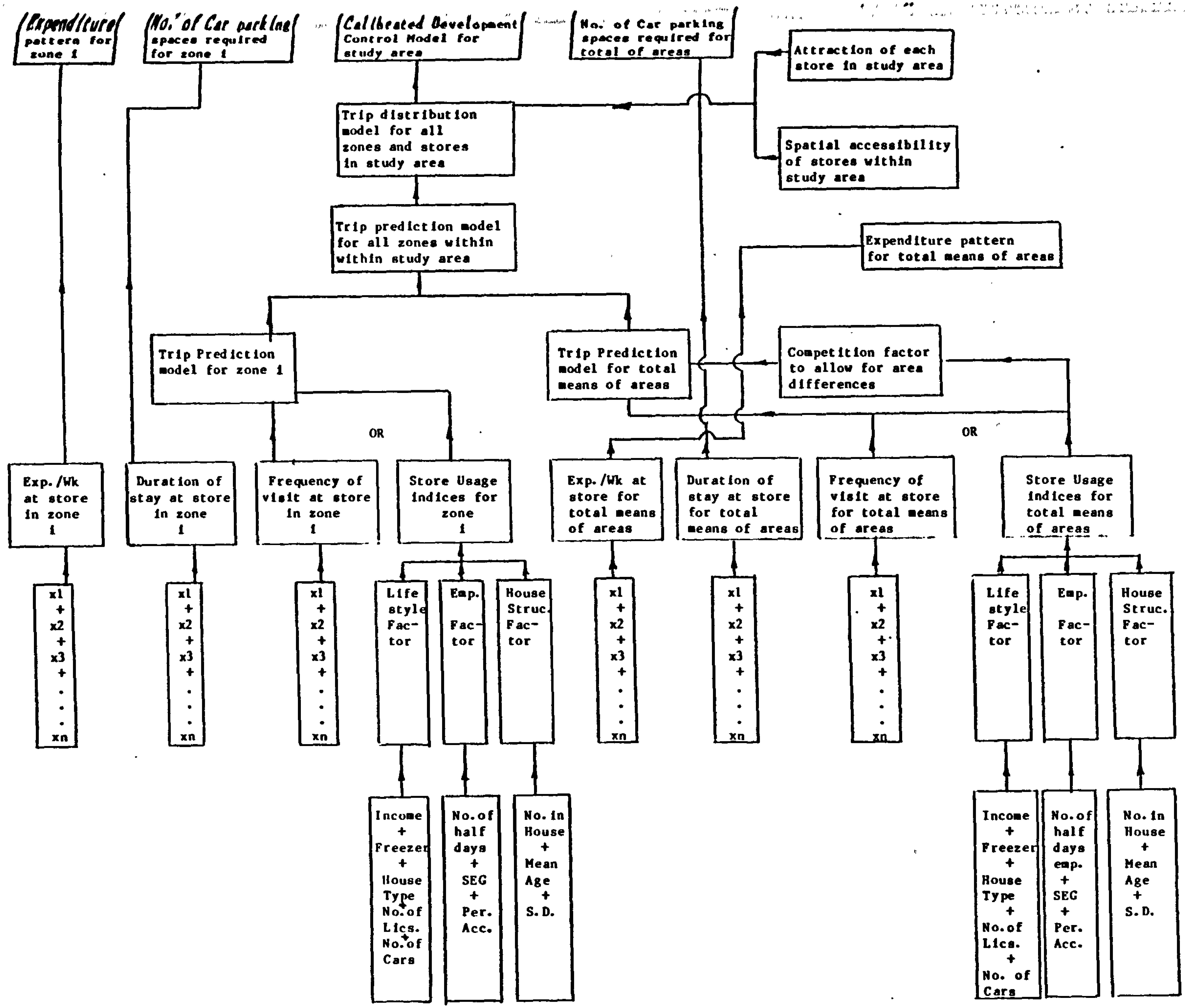


FIGURE 12

Model of Conceptual Framework showing sub-models based on Factor Variables and Individual Variables

CHAPTER 6

THE PLANNING AND ORGANISATION OF THE ENQUIRY

6.1 Introduction

This chapter identifies the research tasks to be carried out following the research objectives and conceptual framework of the previous chapter. The implementation of the research tasks is then discussed and statistical techniques identified which will satisfy these tasks. The analysis assumes a linear relationship between the dependent and independent variables.

The survey area, sampling framework and questionnaire design are discussed and the organisation of the pilot and main surveys. This is followed by a presentation of the initial data characteristics using mean, standard deviation and skewness area profiles. These profiles show the intercorrelation between variables and provide a basis for the detailed analysis of the two conceptual models at area, mean and composite area level in the following chapter.

6.2 The Identification of Research Tasks with respect to the Research Objectives and Conceptual Framework

6.2.1 The conceptual framework developed in Chapter 5 identified two models based on factor variables and individual variables respectively. One of the research tasks is therefore to identify these factors from observed data. Once this has been carried out both models can be analysed to test their predictive ability with respect to private-car trips to large foodstores.

6.2.2 The research objectives demand an examination of these models at area level and at aggregated level. It is proposed to examine the relationship between the dependent and independent variables at area level by computing a matrix of variables, obtaining an aggregated form of the data based on the mean profile of the variables in each area, and an aggregated matrix of the households in all areas. These two forms of aggregation are proposed because the variability at household level may be too large to accommodate within a generalised model but the smoothing of within-area variations using mean variable values may be possible. The latter method is appropriate for the strategic planning of large stores as most transportation studies are based at zonal level.

6.2.3 The examination of the relationships mentioned above must include an investigation of the effect of each variable within each model and the strength of that effect. In addition it will be necessary to understand the strength of the relationships between variables and the spread and form of the data distribution of each variable so that variation between areas can be analysed.

6.2.4 The investigation into the level of generality achievable in the models will require examination of any apparent area groupings, for although all areas may not show the same model relationships groups of areas may be similar. These research tasks imply the application of certain statistical techniques in the analysis of the data and these techniques will now be discussed with respect to the above.

6.2.5 In discussing these techniques it is initially assumed that a linear relationship exists between the dependent and independent variables, this will aid the application of the developed strategic model. If a linear relationship is not found then the proposed suite of programs has the facility to identify the nature of the non-linear relationship.

6.3 The Identification of Methods of Analysis with respect to the Research Tasks

6.3.1 Descriptive Statistics

The basic statistics of the variables to be used are required for the matrix of variable means and to aid in the explanation of the analysis. They will reveal underlying distributional characteristics with respect to a measure of central tendency, degree of dispersion around the mean and degree of skewness that will enable a more precise definition of the variable's slope distribution to be achieved. Throughout the analysis the SPSS suite of programs will be used except for the cluster analysis, which will use GENSTAT, and some minor self-written programs. The SPSS subprogram CONDESCRIPTIVE provides the user with the capability of obtaining the above measures for any set of variables which is more or less continuous and approaches an interval level of measurement. Where the variable is discrete, or a category variable, the number, or proportion of cases which fall into each category, will normally be examined.

6.3.2 Bivariate Correlation Analysis

The input to be used for the identification of the combined variable factors, for the canonical correlation and the multiple regression correlation is a correlation matrix. In addition when examining the relationships between the independent and dependent variable sets at area, mean and aggregate level a knowledge of the strength and sign of the bivariate correlation betwen single pairs of variables is useful.
Bivariate correlation provides a single number which summarises the relationship between two variables. These correlation coefficients indicate the degree to which variation in one variable is related to variation in another. It is also possible to compare the strength of the relationship between one pair of variables and another.

When comparing variables it is highly unlikely that a regression line will be found that perfectly fits the data. The Pearson product-moment correlation coefficient, symbolised by r, gives a measure of "goodness of fit" for linear regression. When the linear regression line is a poor fit r will be near zero; +1.0 indicates a perfect fit. If r is close to zero this indicates either no relationship exists or there is a non-linear relationship. The latter will be checked, where appropriate, using a scatter diagram plot.

If the Pearson r coefficient is squared one gets a measure of the proportion of variance in one variable "explained" by the other. It is important, in the context of the research objectives discussed in the previous chapter, that the inter-correlations between variables are understood.

The SPSS subprogram PEARSON CORR computes the Pearson product-moment correlations for pairs of variables. The formula used by SPSS is :

$$r = \frac{\sum_{i=1}^{N} X_i Y_i - (\sum_{i=1}^{N} X_i)(\sum_{i=1}^{N} X_i)/N}{\{[\sum_{i=1}^{N} X_i^2 - (\sum_{i=1}^{N} X_i)^2/N][\sum_{i=1}^{N} Y_i^2 - (\sum_{i=1}^{N} Y_i)^2/N]\}^{\frac{1}{2}}}$$

Significance tests are reported for each coefficient and are derived from the use of Student's t with N-2 degrees of freedom for the computer quantity,

$$r \left[\frac{N-2}{1-r^2} \right]^{\frac{1}{2}}$$

6.3.3 Principal Components Analysis

The research objectives seek to build a trip generation model based on the relationship between household characteristics and private-car use of large stores and to generalise this relationship as far as the data analysis permits.

The conceptual framework then identified two model forms to achieve these objectives. One of these models is based on three independent factors (employment, household structure and lifestyle) and two dependent factors (large store usage and total shopping usage). These factors are a combination of several inter-related variables. This structure presupposes an underlying structure based on the intercorrelations of the variables which combine to form the factors.

This structure implies a form of factor analysis which enables one to identify whether some underlying pattern of relationships exist such that the data may be rearranged, or reduced, to a smaller set of factors, or components, that may be taken as source variables accounting for the observed inter-relations in the data.

The term "factor analysis" is not a unitary concept and it subsumes a variety of procedures. Generally it can be said to be organised around the major alternatives available at each end of the three customary steps of factor analysis i.e.

1) the preparation of the correlation matrix
2) the extraction of the initial factors
3) the rotation to a terminal solution

In identifying the initial factors the new variables may be defined as exact mathematical transformations of the original data, or assumptions may be made about the structuring of variables and their source of variation. It is proposed to use the former method which is called Principal Components Analysis. It is a relatively straightforward method of transforming a given set of variables into a new set of composite variables, or principal components, that are orthogonal to each other. No particular assumption about the underlying structure is required. The first principal component may be viewed as the single best summary of linear relationships exhibited in the data. The second component is the second best linear combination of variables, under the condition that the second component is orthogonal to the first. To be orthogonal to the first, the second component must account for a proportion of the variance not accounted for by the first one. Thus the second component may be defined as the linear combination of variables that accounts for the most residual variance after the effect of the first component is removed from the data. Subsequent components are defined similarly until all the variance in the data is exhausted.

The principal components model may be expressed as,

$$Z_j = a_{j1} F_1 + a_{j2} F_2 + \ldots\ldots + a_{jn} F_n$$

where each of the n observed variables is described linearly in terms of n new uncorrelated components F_1, F_2 ..., F_n each of which is in turn defined as a linear combination of the n original variables.

The final stage of the analysis is the rotation of the factors to achieve a terminal solution. The exact configuration of the factor structure is not unique, regardless of whether factors are defined or inferred. One factor solution can be transformed into another without violating the basic assumptions, or the mathematical properties of a given solution. Therefore one must choose the best rotational method to arrive at the terminal solution that satisfies the theoretical and practical needs of the research objectives. The two options are the orthogonal method and the oblique method. There is no compelling reason to choose one over the other and it is proposed to use the former of the two methods. It is further proposed that the VARIMAX method of rotation is chosen since it is the most widely used and is a modification of the alternative QUARTIMAX method.

6.3.4 Multiple Regression Analysis

The second model emerging from the conceptual framework consisted of individual variables acting as unique variables and related to the single dependent variables of frequency of use, expenditure and duration of stay. This model implies that multiple regression analysis would be a suitable statistical tool for the analysis of the model structure. Multiple regression is a general statistical technique through which one can analyse the relationship between a dependent, or criterion variable, and a set of independent or predictor, variables.

The basic principles of regression analysis, used in the bivariate case mentioned earlier, may be extended to multiple regression. The general form of the equation is,

$$Y^1 = A + B_1 X_1 + B_2 X_2 + \ldots + B_K X_K$$

where Y^1 represents the estimated value for Y, A is the Y intercept and the B_i are the regression coefficients. The A and B_i coefficients are selected so that the sum of square residuals $(Y - Y^1)^2$ is minimised. This implies that the correlation between the actual Y values and the Y^1 estimated values is maximised, while the correlation between the independent variables and the residual values $(Y - Y^1)$ is reduced to zero.

The SPSS subprogram REGRESSION will be used for this analysis. As in the bivariate case the proportion of variance of Y explained can be evaluated by examining the square of the multiple correlation i.e.

$$R^2 \quad \frac{\text{Variation in Y explained by the combined linear influence of the independent variable}}{\text{Total variation in Y}}$$

Regression procedures per se may be categorised as descriptive statistics, however, it is commonly performed on sample data which the researcher is interested in generalising to a population, as in this study. The goodness of fit test of the regression equation contained in the subprogram is the F-test. This is represented as,

$$F = \frac{SS_{REG}/k}{SS_{RES}/N-k-1}$$

$$= \frac{R^2/k}{(1 - R^2)/(N-k-1)}$$

where SSreg is the sum of squares explained by the entire regression equation, SSres is the residual sum of squares, k is the number of independent variables in the equation and N is the sample size. The F-ratio is distributed approximately as the F-distribution with degrees of freedom k and N - k- 1.

It is proposed to enter the variables using forward step-wise inclusion. The order of inclusion is determined by the contribution of each variable to the explained variance in descending order of importance.

6.3.5 Canonical Correlation Analysis

The preceding two sections have explained how the two model structures proposed will be analysed. The third research objective requires each of these models to be examined to determine the degree of generalisation that can be achieved. Thus it is necessary to examine the structure and each individual variable contribution within each model at area, mean and aggregate level. It is proposed to use canonical correlation analysis for this task as it not only yields the maximum strength of relationship between independent and dependent variables but details the variable weightings which comprise that relationship. These order weightings can then be compared at different levels of aggregation.

Canonical correlation analysis takes as its basic input two sets of variables, each of which can be given theoretical meaning as a set. This corresponds to the sets of dependent and independent variables contained in this study. Then the analysis derives a linear combination from each of the sets of variables in such a way that the correlation between the two linear combinations is maximised. Many such pairs of linear combinations may be derived. These canonical variates are essentially equivalent to the principal components discussed previously, except that the criterion for their selection is not the same. Whereas both techniques produce linear combinations of the original variables, canonical correlation analysis does so not with the object of accounting for as much variance as possible within one set of variables but with the aim of accounting for a maximum amount of the relationship between two sets of variables.

This type of analysis enhances the other forms of analysis used and is suited to the conceptual framework of variables identified. The SPSS subprogram CANCORR will be used and the correlation matrix will form the input data. As with principal components analysis CANCORR manipulates intercorrelations among the variables to search for particular data patterns. The structure and variable weightings of the canonical variates is not explained and must be interpreted with respect to the conceptual framework.

6.3.6 <u>Cluster Analysis</u>

The aim of the study, as discussed in the previous chapter, is to build a generalised trip generation model from the relationship established at area level between the dependent and independent variable sets. This generalisation may not be possible and if this is so two alternatives exist. Either every area has a different relationship or groups of areas have the same relationship. It may therefore be necessary to apply a clustering technique to the data to identify common groups of areas. The object of this being to assess the level of generality, or aggregation, achievable in the data set in accordance with the third research objective.

A fundamental problem with cluster analysis is the lack of satisfactory definition of what constitutes a cluster. Most clustering techniques cannot be formulated in terms of a satisfactory model because of this problem. The clusters, or groups, will tend to be chosen on an intuitive basis. The SPSS suite has no cluster analysis program so it is proposed to use the GENSTAT sub-program.

6.3.7 Other Statistical Tests

Other small programs will require to be written as the analysis proceeds and these will be explained within the analysis report.

6.4 Identifying the Survey Area

6.4.1 The study is based in the City of Edinburgh which has a number of large shopping stores within its boundary. Each store exerts an attractive power over a considerable catchment area and forms an overlapping competitive framework within the City. The geography of the area means that a green-belt buffer zone exists outside the City boundary and the nearest urban centres to the City are on the periphery of the nearest store catchment areas. Although shopping trips do take place between these areas and City stores the percentage is small relative to the total private-car trip generation. The Regional Council found this figure to be of the order of 1% for a particular store on the City boundary.

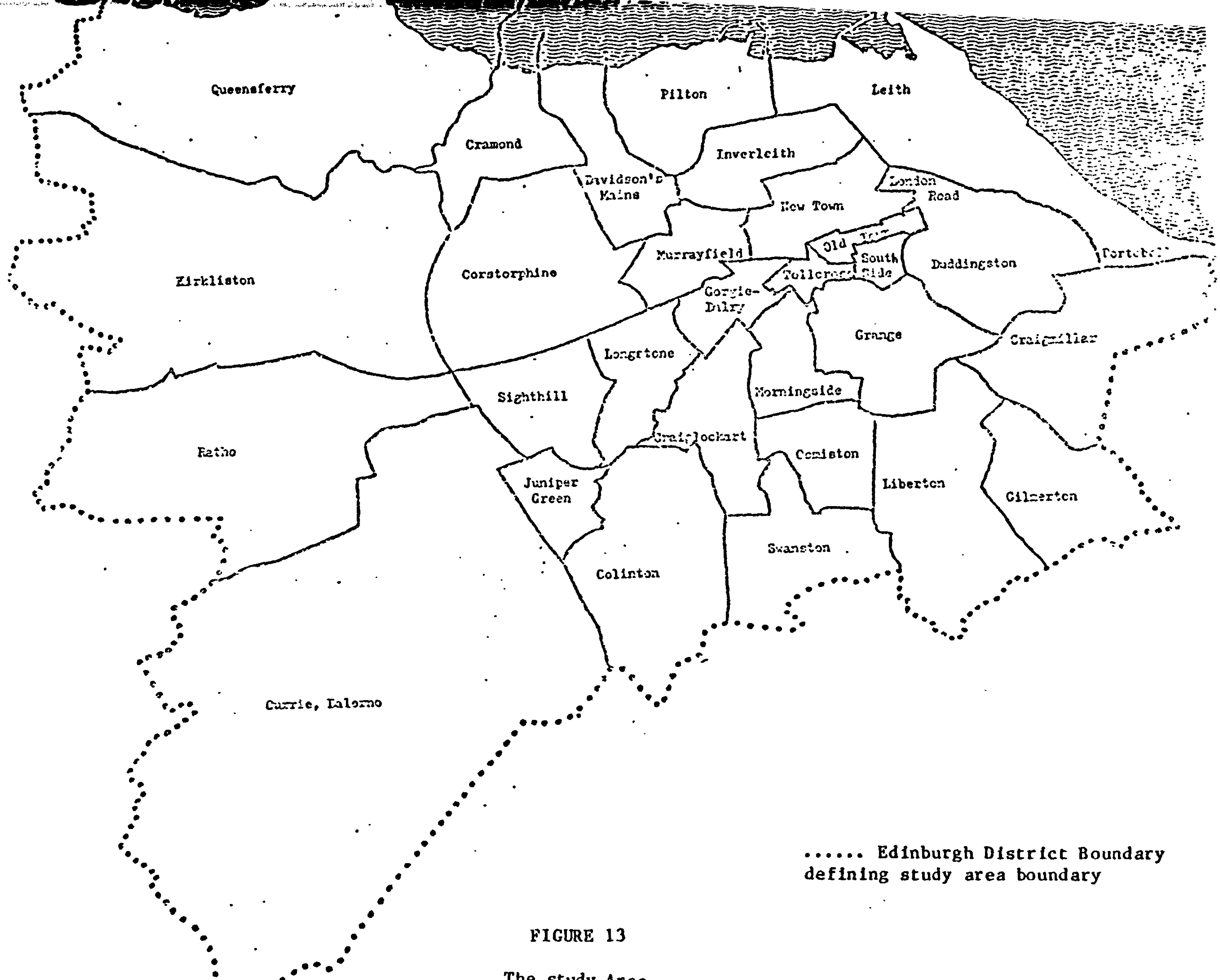
6.4.2 It is proposed, therefore, that the City boundary be taken as defining the survey area. This corresponds with planning zones and hence ennumeration district boundaries on which census data is based. The study area is shown in Figure 13.

6.5 The Sampling Framework and Technique

6.5.1 It has been established in the previous chapter that to examine if there is a relationship between household characteristics and store usage the effect of competition has to be held constant. It was proposed to use stratified sampling to group households in areas which will have equal shopping opportunities and hence the same competitive framework.

6.5.2 The sampling element chosen is the household, as previously discussed, and the area group of households will be randomly sampled so that they can be aggregated and retain their random nature. There are 1,529 Ennumeration Districts within the study area and these represent 229,000 households (1981 census). The financial constraint has limited the number of households to 400 which is a sample of 0.2% of the total households. From the experience of previous surveys of this nature undertaken at Cranfield Institute of Technology, Edinburgh University and Napier College and the experience of statisticians at Edinburgh University and Napier College, this sample number is acceptable. Given the number of variables in the conceptual models and the sample number it is proposed to sample fifteen areas each of which have twenty-seven households.

6.5.3 Each Ennumeration District was then given a number, omitting those districts which were defined as "institutions". These listings are shown in Appendix C.



...... Edinburgh District Boundary
defining study area boundary

FIGURE 13

The study Area

Fifteen districts were then chosen using a random number generator and these are highlighted in Appendix C. The postcodes for these districts were obtained and a list of addresses compiled for each area.

6.5.4 The next stage in the sampling process was to identify the car-owning households within the list of addresses for each area. The vehicle licensing centre at Swansea was approached but would not divulge the information. The only way to secure the information is by inquiring at each household and if the household did not possess a car passing to the next household. This process will continue until the sample size in each area is achieved. It is not possible to assess whether this introduces a small bias to the sample.

6.6 The Questionnaire design

6.6.1 The principles of design for the questionnaire are as follows :

i) the questionnaire will be in four parts; a general section, conforming to the lifestyle factor identified in the conceptual framework, a household structure section which collects information related to individuals within the household, a personal accessibility section, which conforms to the principles discussed in Chapter 4 and a shopping diary section.

ii) the questionnaire should be structured in such a way that answers can be ticked in boxes given on the questionnaire wherever possible. This aids speed of response and the computerising of the data.

iii) the indexing of the variables identified in Chapter 3 will conform to the proposals in that chapter.

iv) the colour of the questionnaire to be light green as this elicits a better response rate from the personal past experience of Dr M Benwell at Cranfield Institute of Technology. The questionnaire will also be laid out neatly and presented professionally on good quality paper with the Napier College crest.

6.6.2 The general information section obtains information on house type, freezer ownership, number of cars in the household and income of the household. This corresponds to the lifestyle factor in the conceptual framework of one model. The number of licenses in the household is not included in this section as it pertains to the individual members of the household. The second section identifies the age structure of the household, which follows the principle employed for income and uses agebands, and the employment structure of the household. In addition a coding is given relating members of the household to the head of the household. This is included for possible further analysis of household structure. The third section is presented in tabular form so that the interviewer or interviewee can quickly tick the times when the principal shopper and car are available. These can then be visually checked to obtain a ratio based on eighteen periods when the car, principal shopper and store are available simultaneously. In other words it measures the accessibility window of the household. The fourth section is a standard household shopping diary which obtains information, based on a typical week, on shopping expenditure, duration of stay and frequency of visit. If the household conducts a major shopping trip outside this period this should be noted, with the details, on the diary. As proposed in the previous chapter shopping trips with expenditures under £2.00 are not to be noted in addition to major non-food items.

6.7 The Pilot Survey

6.7.1 A pilot survey was undertaken, during March 1981, to test the effectiveness of the questionnaire design. The survey covered one hundred and fifty households in four areas of Edinburgh; Morningside, Grange, Buckstone and Balcarres. These areas are very different in character and provided a broad test for the questionnaire.

6.7.2 No major problems were encountered and the layout worked efficiently and effectively. The survey confirmed that the household could identify a principal shopper, usually the wife, and the personal accessibility table worked well. There was some confusion between gross and net household income so the questionnaire now has a heading for gross income as this was the measure to which most people could relate. The finalised questionnaire is shown under Figure 14.

6.8 The Organisation of the Survey

6.8.1 The survey was undertaken by one person employed on a full-time basis over two weeks during September 1982. This provided consistency of approach in the interviewing and was an efficient way of carrying out the survey since the interviewer became both experienced and faster as the survey progressed. The interviewer was fully briefed and given a letter of authorisation from Napier College in addition to a badge showing his name and the College name. A letter was also sent to every potential householder explaining the purpose of the survey, the confidentiality of the data and the method of survey. The interviewer carried copies of the letter to cover households that had not received it. This method proved most successful. The letters of authorisation and information are shown in Appendix D. The District Authority and the police were also informed.

NAPIER COLLEGE
DEPARTMENT OF CIVIL ENGINEERING
SHOPPING SURVEY FOR RESEARCH INTO THE TRAFFIC IMPACT OF SUPERSTORES

Interviewer Number
Survey Form Number
Date of Interview
Time of Interview

SECTION 1 - General Household Information

1.1 House Type : Owner/Occupier
Council Rented
Privately Rented
Other (Specify)...
....

1.2 Freezer Ownership : Yes
No

1.3 Number of cars/vans regularly used by the household :

1.4 Total Household Income per annum :

Gross Income		
0	-	£ 3,000
£ 3,000	-	£ 6,000
£ 6,000	-	£ 9,000
£ 9,000	-	£12,000
£12,000	-	£15,000
£15,000	-	£20,000
£20,000	-	£25,000
£25,000	+	

1.5 Tick the lines when the principal shopper could be available to shop if so desired | Tick the lines when a car could be available if the principal shopper should wish it

M		
A		
E		
M		
A		
E		
M		
A		
E		
M		
A		
E		
M		
A		
E		
M		
A		
E		
M		
A		
E		

Notes :
1) Time of Day : Morning 9.00 am - 12.00
Afternoon 12.00 - 5.00 pm
Evening 5.00 pm - 8.00 pm

Section 2 - Household Characteristics

No. in H/H	Household Status (relative to Head of Household)	Code	Age Band Grouping (1 to 5)	Sex (M or F)	Occupation Description	SEG Code	No of days of the week employed (Days/½ Days)	Code	Hours of Employment (Hrs)	Code	Private Car Licence (Y/N)
	Head of Household	HH									
	Wife/Husband	W/H									
	Son	S									
	Daughter	D									
	Parent	P									
	Grand Parent	GP									
	Sister	SR									
	Brother	BR									
	Other Relative	OR									
	Boarder	B									

Notes : 1) Age Band Groupings : (1) = 0-16 yrs; (2) = 17-30 yrs ; (3) = 30-45 yrs; (4) = 45-60 yrs; (5) = 65 yrs or over
2) Please tick Interviewee

Section 4 - Shopping Diary

Shopping Trip No.	Where did you shop?	Day of the week	Start Time	Finish Time	Method of Transport	Approximately how much did you spend on this trip?
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						
10.						

FIGURE 14

The Questionnaire Design

6.9 Setting up the Data Files

6.9.1 A data file for each area was created and the variables indexed according to the questionnaire coding and the conceptual framework. The field widths and indexing is shown in Table 8. The coded data for each area are set out in Appendix E. A further data file was created which aggregated all the areas into one file of four hundred households. The files were given names HAZEL1 to HAZEL16 and are mounted on a PRIME 750 computer. It will be noted that not all areas have twenty-seven households. This is because of invalid returns with respect to failure to answer certain questions. This can be clearly seen in area 11 where a large number of households refused to answer the questions on income and employment. It is considered that the remaining data will be sufficient for the analysis.

6.10 The Presentation of the Initial Data Characteristics

6.10.1 The locations of the fifteen areas are shown in Figure 15. They show a good spread over the City and reflect the various types of housing within the City.

6.10.2 In accordance with the research tasks the mean value of each variable was calculated, for all areas, and a means data matrix, MEANS1, was created. The means of the variables are shown in Table 9 and their profiles are plotted in Figures 16 and 17.

6.10.3 A number of points emerge from the initial inspection of the figures. The greatest variations are seen in Area 5 (Waverley), Area 6 (Westburn), Area 10 (Pilton), Area 12 (Turnhouse), Area 13 (Leith) and Area 14 (Craigleith). Area 5 is an area of low bulk-buying habit preferring to shop at smaller stores. It is an inner-city area of low

Columns	Variable Name	Variable Description	Remarks
1 - 3	A	Area number	A number from 1 - 15
4 - 9	B	Duration/week at Store	Number of hours to two decimal places
10 - 14	C	Duration/week for all shopping	As above
15 - 20	D	Expenditure per week at Store	Number of £ to two decimal places
21 - 26	E	Total Expenditure for all shopping trips	As above
27 - 31	F	Frequency/Week of visit to Store	The number of times in the week the store is visited
32 - 36	G	Total frequency/week for all shopping trips	As above but for all shopping
37 - 38	H	House type	1, 2, 3 or 4
39	I	Freezer ownership	1 or 0
40 - 41	J	Number of cars/vans used regularly by the household	Number of cars/vans
42 - 43	K	Income band of the household	Number from 1 to 8
44 - 45	L	Number of licences in the household	Number of licences
46 - 47	M	Number of people in in the household	Number of people
48 - 49	N	Mean age of people in the household	Mean age
50 - 53	O	Standard deviation of ages of the household	Standard deviation
54 - 56		SEG of the head of the household	SEG group number
57 - 59		Number of half days/ week of employment in the household	Number of half days
60 - 62		Personal accessibility index of the principal shopper	A number between 0 and 18

TABLE 8

Coding and Indexing of variables for data files

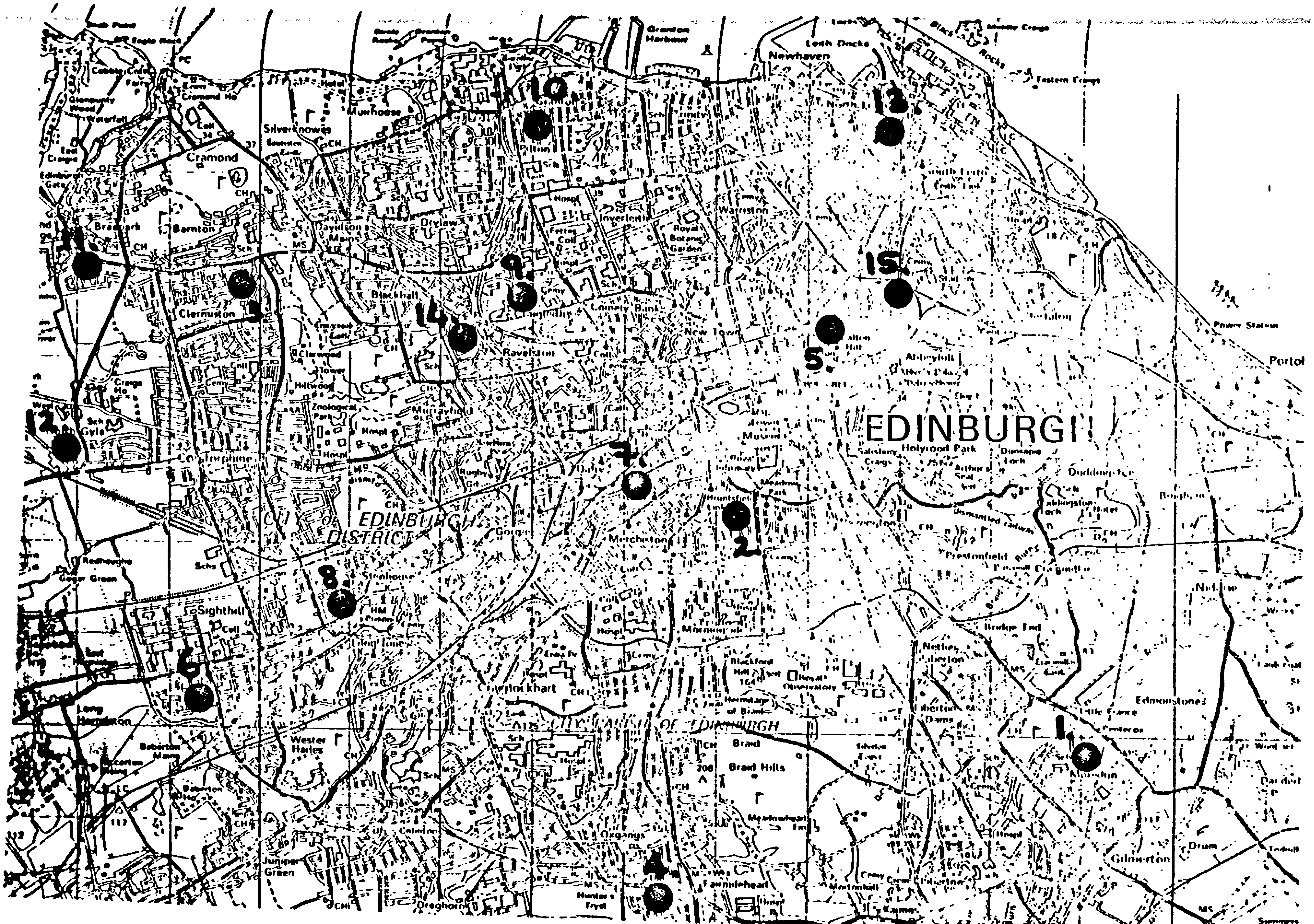


FIGURE 15

Map of Area Locations

	Area	B	C	D	E	F	G	I	J	K	L	M	N	O	P	Q	R
1.	Moredun	0.9	1.9	17.9	30.0	0.7	1.8	0.6	1.6	2.7	1.4	2.9	44.9	11.1	11.7	9.1	13.0
2.	Spottiswoode	0.9	2.0	17.0	29.2	0.6	2.4	0.5	1.1	2.6	1.3	2.3	46.0	8.4	12.4	8.2	13.3
3.	Clermiston	1.0	2.0	15.7	27.5	0.7	1.8	0.3	1.0	2.7	1.2	2.3	51.4	4.4	9.9	13.2	11.7
4.	Swanston	1.1	2.3	21.0	31.2	0.9	2.1	0.7	1.4	4.0	1.9	3.2	38.7	12.0	7.4	12.5	13.9
5.	Wav./Reg.Place	0.9	2.6	13.9	26.4	0.7	3.6	0.4	1.0	2.2	1.0	2.4	52.4	6.4	12.4	6.2	11.6
6.	Westburn Park	1.0	1.6	25.2	32.9	1.1	2.1	0.2	1.0	2.8	1.3	3.4	31.4	12.7	10.6	12.5	11.4
7.	St Peters Pl.	0.9	1.6	20.8	28.8	0.8	1.9	0.5	1.2	3.6	1.6	2.5	30.1	7.6	7.4	12.8	10.2
8.	Saughton Mains	1.0	2.5	21.6	27.3	0.9	2.7	0.7	1.1	3.5	1.4	3.3	48.5	11.8	12.3	16.4	12.2
9.	Craigleith Hill Ave.	0.9	1.8	18.7	26.3	0.7	1.7	0.6	1.2	3.8	1.5	2.9	43.6	11.4	10.0	12.9	11.1
10.	Pilton	0.8	2.6	18.5	38.1	0.6	3.1	0.4	1.1	2.6	1.3	3.6	41.3	8.8	11.7	13.1	10.7
11.	Cammo	1.1	2.0	26.3	34.1	1.1	2.6	0.9	1.7	4.9	2.1	3.2	43.3	14.1	8.1	11.6	15.4
12.	Turnhouse	1.3	2.4	28.1	38.1	1.1	2.5	0.7	1.2	4.0	1.8	3.3	31.1	12.2	6.4	13.9	12.7
13.	Leith	1.1	3.4	16.7	32.1	0.8	2.8	0.2	1.1	2.9	1.3	3.5	38.6	13.2	11.0	10.5	10.9
14.	Craigleith Cres/View	1.1	2.1	25.8	38.2	1.0	2.6	0.9	1.3	4.7	1.8	2.9	49.1	9.1	9.3	8.7	15.0
15.	Easter Rd/Dalry	1.2	2.3	20.1	29.6	1.1	2.8	0.3	1.1	2.9	1.3	2.9	37.1	9.4	10.3	9.5	12.4
16.	All Areas	1.0	2.2	20.6	32.0	0.8	2.4	0.5	1.2	3.3	1.5	3.0	41.7	10.1	10.0	11.5	12.3

B = Hours of Week at Store
C = Total Hours/Week
D = Expenditure/Week at Store
E = Total Expenditure/Week
F = Frequency/Week at Superstore
G = Total Frequency/Week

I = Freezer Ownership
J = No. of Cars
K = Income
L = No. of Licences
M = No. in Household
N = Mean Age in Household

O = S.D. OF Age
P = S.E.G.
Q = Employment
R = Personal Accessibility

TABLE 9

Variable Means for each Survey Area

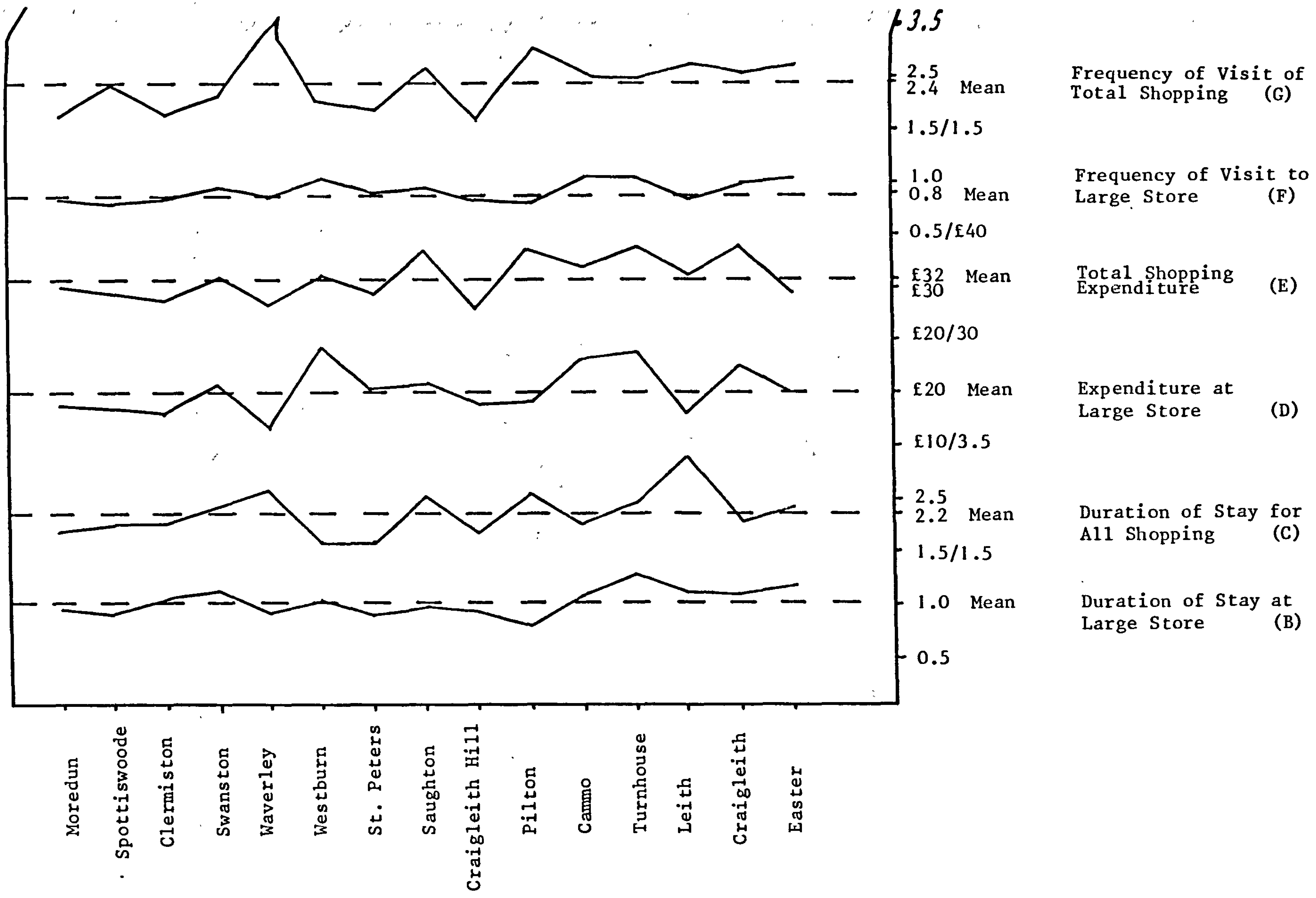


FIGURE 16

Profiles of the Dependant Variables with respect to their Means

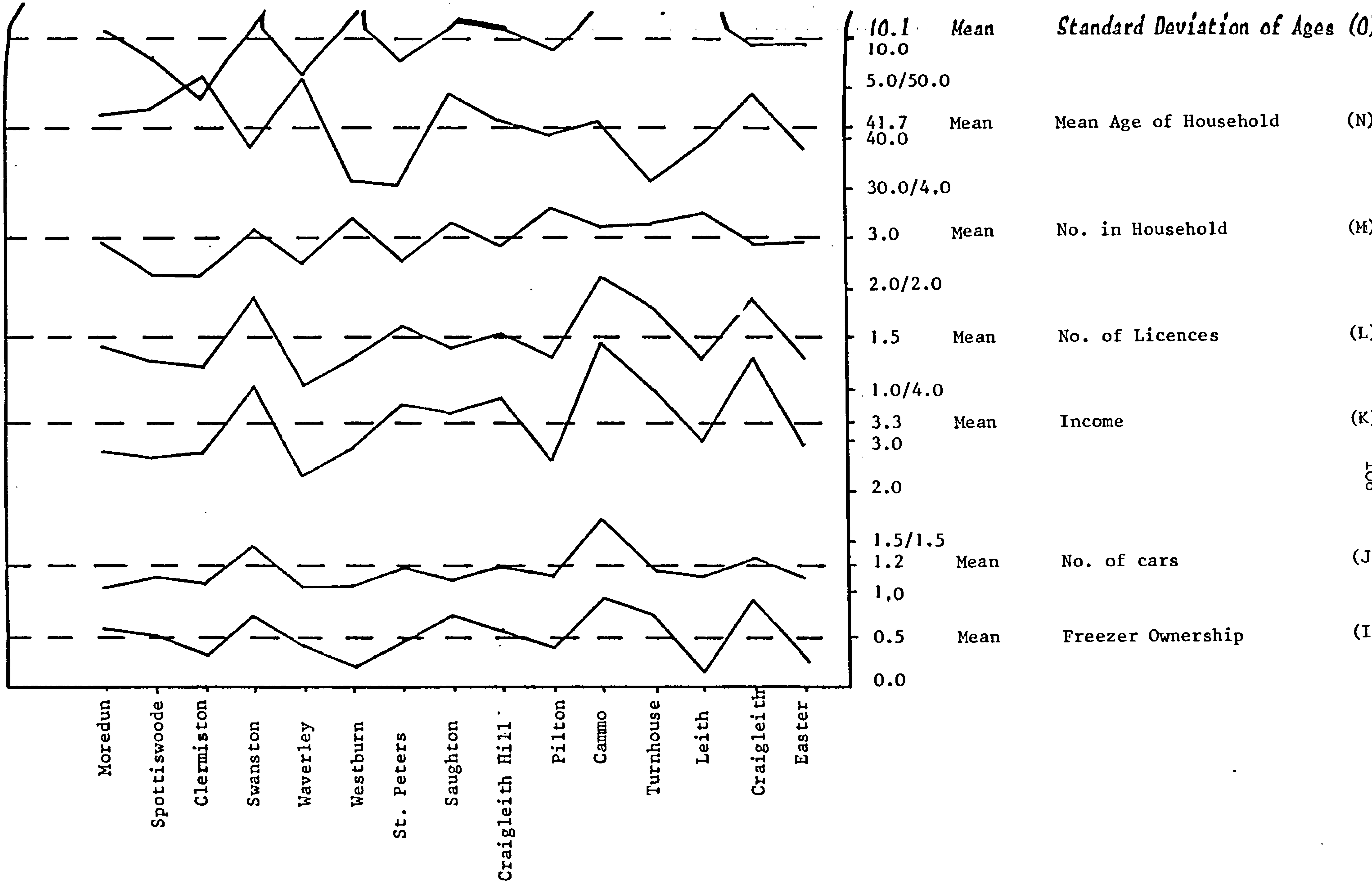


FIGURE 17(a)

Profiles of the Independent Variables I to O with respect to their Means

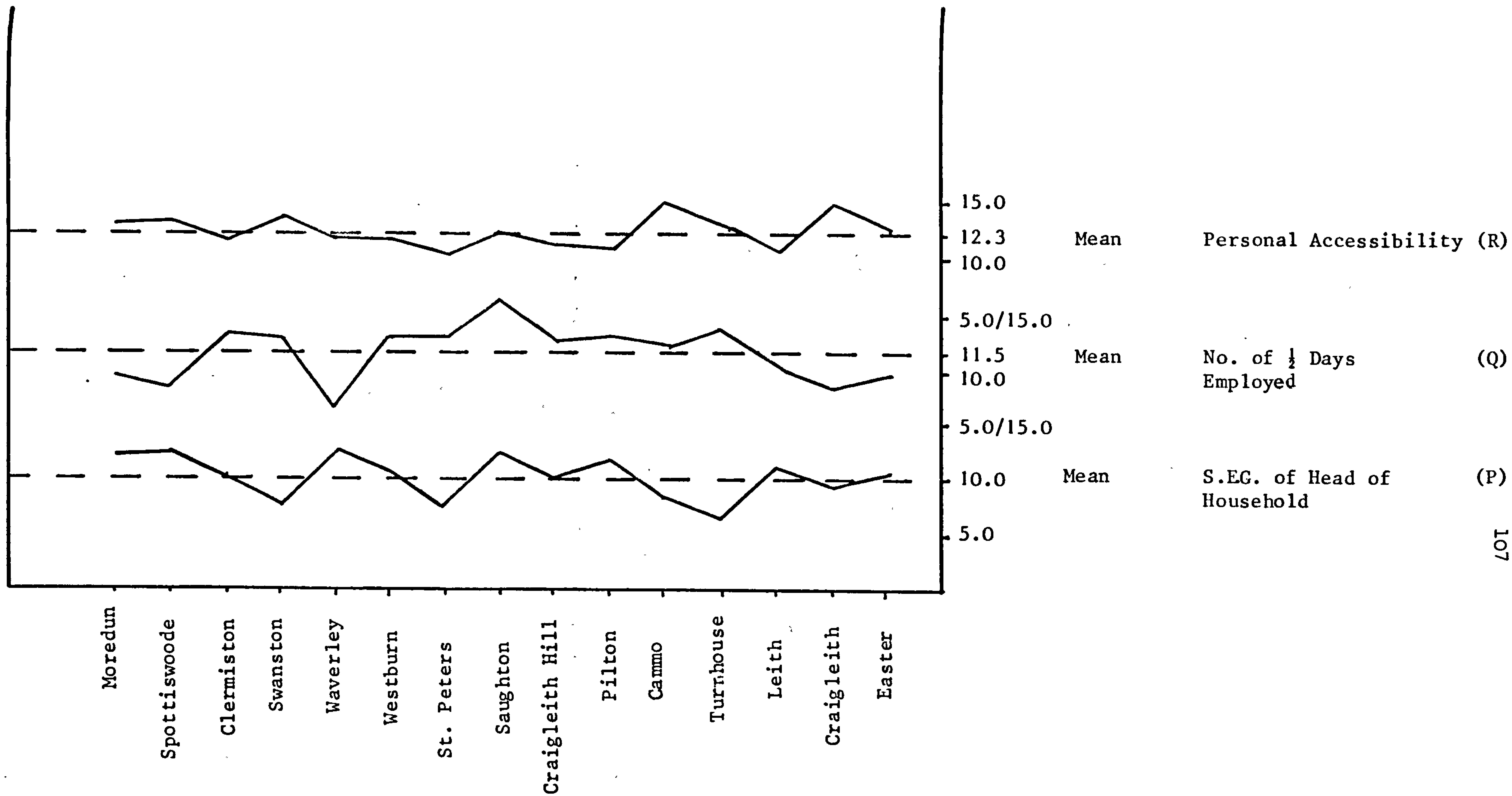


FIGURE 17(b)

Profiles of Independent Variables P to R with respect to their Means employment and income, low car-ownership and high mean age. It is an area with a large number of retired persons who neither have the demand, income, nor the accessibility to bulk-buy at large stores.

6.10.4 The Area 6 (Westburn) profile highlights the locational influence of the proximity of a large store. Area 6 is adjacent to a suburban shopping centre. Although freezer ownership, car ownership and income are all low the use of the store is high. The mean age of the household is low.

6.10.5 The Area 10 (Pilton) profile shows the depressed nature of this area. A large average number in the household but low income, car and freezer ownership. The employment is above average, reflecting the large family size and this enables the weekly shopping budget to rise above average, although this is not translated into above average use of large stores.

6.10.6 The Area 12 (Turnhouse) profile shows it to be a prosperous area with a low mean age indicating a high proportion of young families. The shopping budget is above average both for total shopping and bulk-buying even although this area is on the outskirts of the City.

6.10.7 The Area 13 (Leith) profile shows a high shopping activity but below average expenditure on bulk-buying of food. It is an area of low income with a significant proportion of large families.

6.10.8 Area 14 (Craigleith) is a rich, inner suburb similar in character to Cammo, Swanston and Turnhouse. It is an area of high income, freezer ownership and average number of licenses in the household. The population is older but not retired. The family size is small indicating many children have now left home to further their careers leaving the parents in a mid-life period.

6.10.9 From these profiles areas can be grouped according to "wealth", or age, etc. For example areas 6, 7 and 12 all have low household mean ages. It is also worthy of note that certain variable profiles match. For example the number of licenses in a household and income. Even at this early stage of the analysis it can be seen from the description of the areas above that factors combine to influence the shopping pattern of the household.

6.10.10 A similar exercise to the means distribution was carried out for the standard deviations of each variable. Table 10 and Figures 18 and 19 show the details. It can be seen that the variable dispersion varies considerably from area to area. Freezer ownership, personal accessibility, socio-economic group (SEG) and employment are all relatively equal in profile but the other variables show a range in dispersion pattern. It may have been expected that a uniformity of dispersion would have occurred in such closely located groups however this is not the case and begs the question as to what causes this variability in dispersion.

6.10.11 Tables 11 and 12 show the same type of relative comparison between areas with respect to standard error and skewness respectively. These tables will be referred to later in the analysis.

6.11 Concluding Remarks

6.11.1 This chapter has discussed the analytical implications of the research tasks emanating from the conceptual framework and research objectives. It is assumed that in the first instance a linear relationship exists between household characteristics and store usage and the proposed analytical methods are based on this assumption. If a linear relationship does not exist it is possible to investigate non-linear relationships.

		B	C	D	E	F	G	I	J	K	L	M	N	O	P	Q	R
1.	Moredun	1.0	1.1	14.2	9.1	0.6	1.4	0.5	0.2	1.5	0.6	1.0	17.6	9.0	5.8	7.8	5.0
2.	Spottiswoode	0.8	1.1	13.6	18.1	0.4	2.0	0.5	0.3	1.2	0.7	1.3	18.7	10.4	5.5	8.0	4.9
3.	Clermiston	0.9	1.1	14.4	15.2	0.5	1.6	0.5	0.0	0.8	0.4	1.1	13.1	7.1	5.3	8.9	4.7
4.	Swanston	0.8	1.5	13.6	11.8	0.5	1.3	0.5	0.6	1.5	0.7	1.1	16.9	8.6	5.5	7.3	4.9
5.	Wav./Reg.Place	0.7	2.4	10.1	14.3	0.4	3.5	0.5	0.2	1.1	0.7	1.1	21.1	7.9	5.35	6.9	5.7
6.	Westburn Park	0.5	1.0	12.5	11.6	0.5	1.5	0.4	0.2	0.9	0.5	1.4	16.2	6.8	3.7	8.5	5.1
7.	St Peters Pl.	0.6	1.0	15.9	15.4	0.5	1.9	0.5	0.6	1.4	0.5	1.2	12.1	8.8	5.1	7.9	4.8
8.	Saughton Mains	1.0	1.6	20.7	18.5	0.8	1.7	0.5	0.3	1.7	0.7	1.5	15.9	9.9	4.9	15.0	5.7
9.	Craigleith Hill Ave.	0.9	1.4	14.2	11.5	0.7	1.2	0.5	0.4	1.6	0.8	1.1	18.0	9.3	5.4	10.8	5.2
10.	Pilton	0.9	1.4	17.9	19.0	0.6	1.9	0.5	0.3	1.1	0.6	1.9	19.7	8.6	5.1	10.7	5.4
11.	Cammo	0.6	0.9	19.1	20.1	0.6	1.3	0.3	0.9	1.8	1.1	1.5	18.5	8.8	7.5	10.9	7.3
12.	Turnhouse	0.8	1.7	15.3	16.4	0.6	1.7	0.5	0.4	1.1	0.5	1.3	13.4	9.5	4.3	7.9	5.0
13.	Leith	0.7	3.7	9.5	15.0	0.4	2.1	0.4	0.3	1.3	0.6	1.5	18.4	8.8	4.8	8.7	6.2
14.	Craigleith Cres/View	0.6	1.0	14.5	17.3	0.6	1.5	0.3	0.6	2.0	0.9	1.4	18.3	9.1	7.5	8.2	4.5
15.	Easter Rd/Dalry	0.5	1.3	10.6	12.6	0.5	1.6	0.5	0.3	0.8	0.5	0.9	20.2	8.2	5.6	7.0	5.3
16.	All Areas	0.8	1.7	15.0	15.6	0.6	1.9	0.5	0.4	1.5	0.7	1.4	18.5	9.0	5.7	9.4	5.3

B = Hours of Week at Store
C = Total Hours/Week
D = Expenditure/Week at Store
E = Total Expenditure/Week
F = Frequency/Week at Store
G = Total Frequency/Week

I = Freezer Ownership
J = No. of Cars
K = Income
L = No. of Licences
M = No. in Household
N = Mean Age in Household

O = S.D. OF Age
P = S.E.G.
Q = Employment
R = Personal Accessibility

TABLE 10

Variable Standard Deviations for Each Survey Area

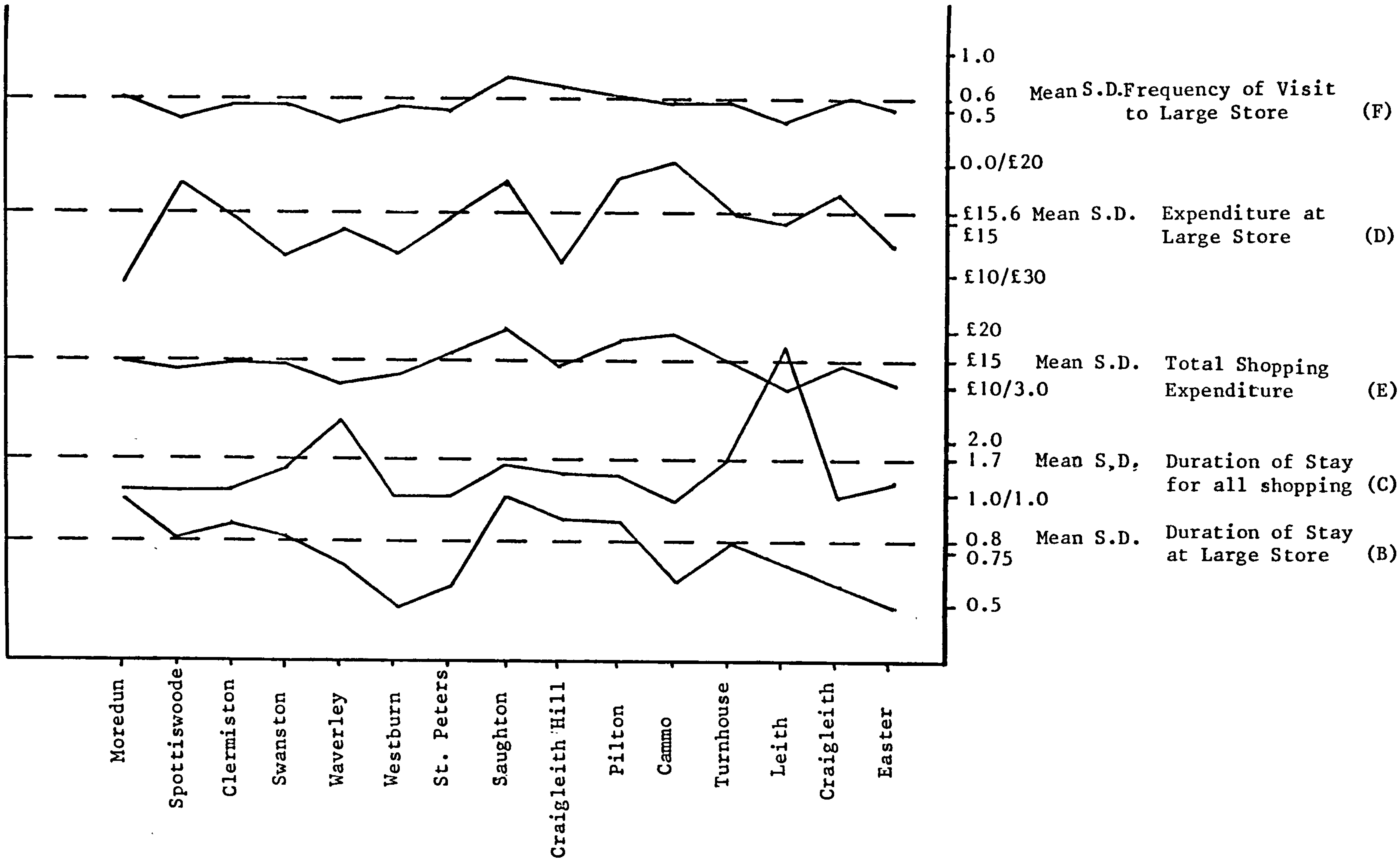


FIGURE 18

Profiles of Dependent Variables with respect to Standard Deviation

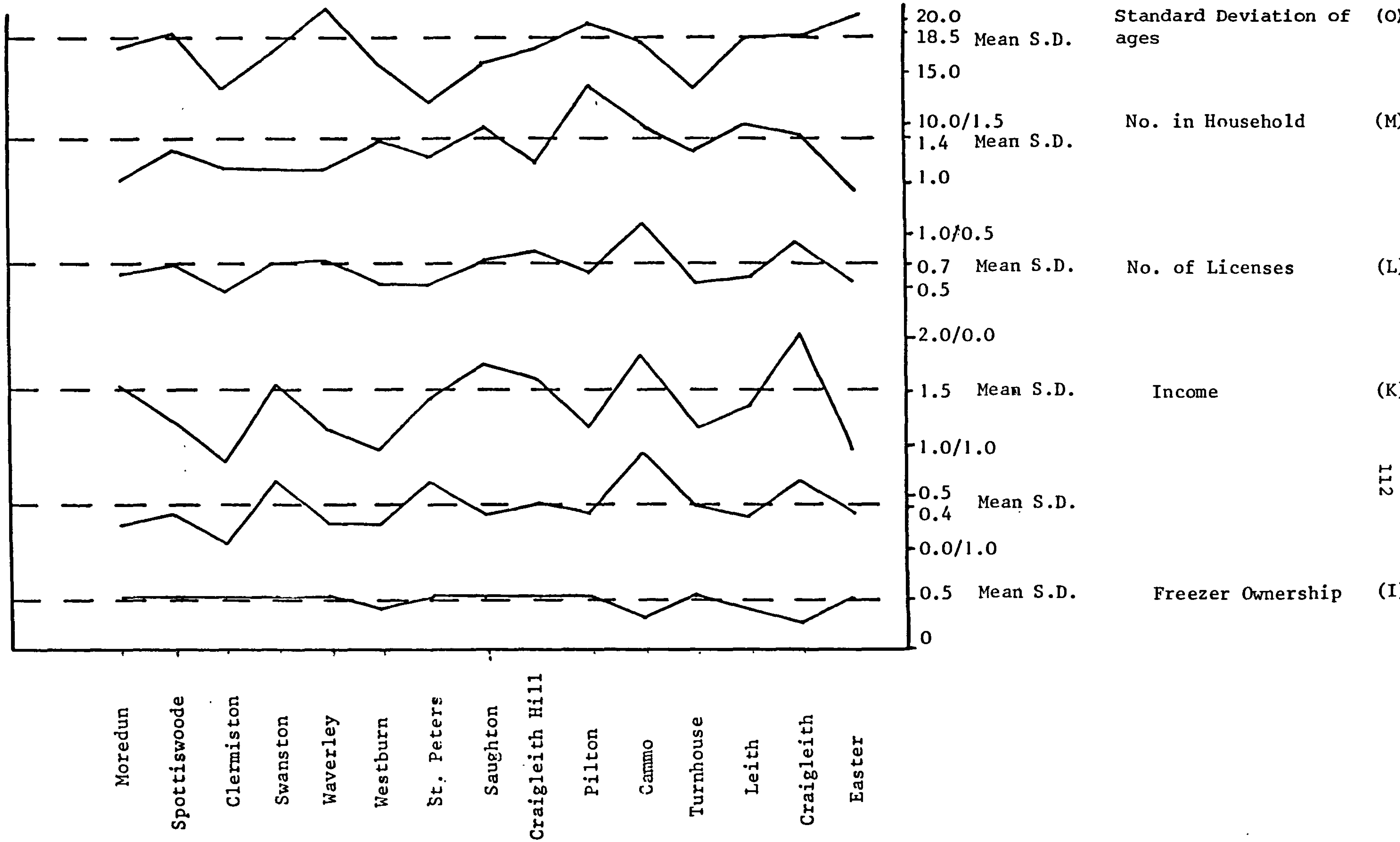


FIGURE 19(a)

Profiles of Independent Variables I to O with respect to Standard Deviation

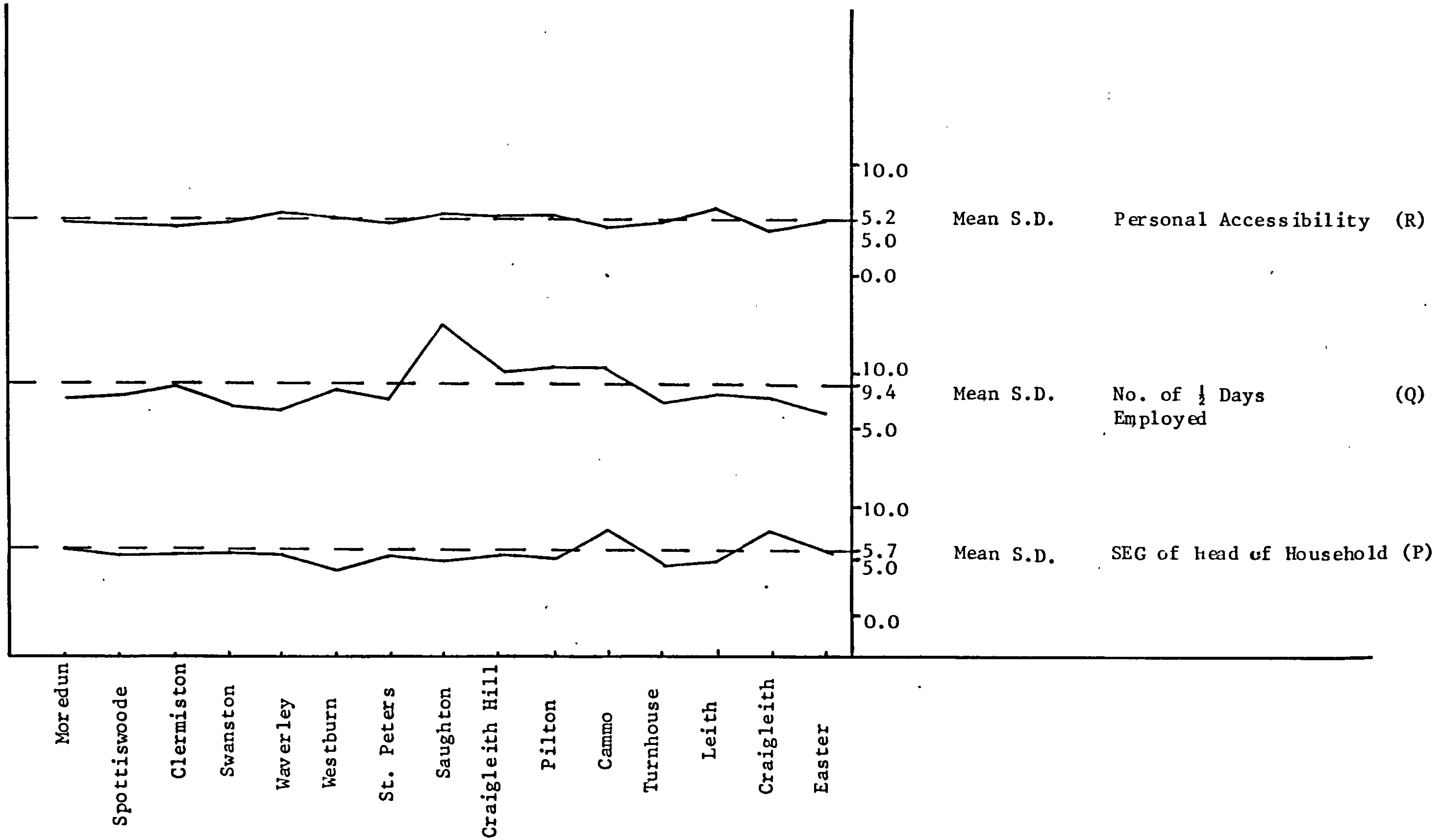


FIGURE 19(b)

Profiles of Independent Variables P to R with respect to Standard Deviation

		B	C	D	E	F	G	I	J	K	L	M	N	O	P	Q	R
1.	Moredun	0.2	0.2	3.0	1.9	0.1	0.3	0.1	0.0	0.3	0.1	0.2	3.8	1.9	1.2	1.7	1.1
2.	Spottiswoode	0.2	0.3	3.1	4.2	0.1	0.5	0.1	0.1	0.3	0.2	0.3	4.3	2.4	1.3	1.8	1.1
3.	Clermiston	0.2	0.2	3.0	3.2	0.1	0.3	0.1	0.0	0.2	0.1	0.2	2.7	1.5	1.1	1.9	1.0
4.	Swanston	0.2	0.3	2.7	2.3	0.1	0.3	0.1	0.1	0.3	0.1	0.2	3.3	1.7	1.1	1.4	1.0
5.	Wav./Reg.Place	0.1	0.5	2.0	2.9	0.1	0.7	0.1	0.0	0.2	0.1	0.2	4.2	1.6	1.1	1.4	1.1
6.	Westburn Park	0.1	0.2	2.7	2.5	0.1	0.3	0.1	0.0	0.2	0.1	0.3	3.5	1.5	0.8	1.9	1.1
7.	St Peters Pl.	0.1	0.2	3.1	3.0	0.1	0.4	0.1	0.1	0.3	0.1	0.2	2.3	1.7	1.0	1.5	0.9
8.	Saughton Mains	0.2	0.3	4.1	3.6	0.2	0.3	0.1	0.1	0.1	0.3	0.1	3.1	1.9	1.0	2.4	1.1
9.	Craigleith Hill Ave.	0.2	0.3	2.7	2.2	0.1	0.2	0.1	0.1	0.3	0.1	0.2	3.5	1.8	1.0	2.1	1.0
10.	Pilton	0.2	0.3	3.5	3.7	0.1	0.4	0.1	0.1	0.2	0.1	0.4	3.8	1.7	1.0	2.1	1.0
11.	Cammo	0.2	0.2	4.8	5.0	0.1	0.3	0.1	0.2	0.4	0.3	0.4	4.6	2.2	1.9	2.7	1.1
12.	Turnhouse	0.1	0.3	3.0	3.2	0.1	0.3	0.1	0.1	0.2	0.1	0.3	2.6	1.9	0.8	2.7	1.0
13.	Leith	0.1	0.7	1.8	2.9	0.1	0.4	0.1	0.1	0.2	0.1	0.3	3.5	1.7	0.9	1.7	1.2
14.	Craigleith Cres/View	0.1	0.2	2.9	3.4	0.1	0.3	0.1	0.1	0.4	0.2	0.3	3.6	1.8	1.5	1.6	0.9
15.	Easter Rd/Dalry	0.1	0.3	2.03	2.4	0.1	0.3	0.1	0.1	0.2	0.1	0.2	3.9	1.6	1.1	1.3	1.0
16.	All Areas	0.0	0.1	0.8	0.8	0.0	0.1	0.0	0.0	0.1	0.0	0.1	1.0	0.5	0.3	0.5	0.3

B = Hours of Week at Store
C = Total Hours/Week
D = Expenditure/Week at Store
E = Total Expenditure/Week
F = Frequency/Week at Store
G = Total Frequency/Week

I = Freezer Ownership
J = No. of Cars
K = Income
L = No. of Licences
M = No. in Household
N = Mean Age in Household

O = S.D. OF Age
P = S.E.G.
Q = Employment
R = Personal Accessibility

TABLE 11

Variable Standard Errors for Each Survey Area

		B	C	D	E	F	G	I	J	K	L	M	N	O	P	Q	R
1.	Moredun	1.5	0.9	-0.1	0.6	0.2	1.7	-0.6	4.7	1.0	1.1	-0.0	0.1	0.0	-0.3	0.9	-0.1
2.	Spottiswoode	0.2	1.1	0.2	1.4	-0.2	0.9	0.1	2.8	1.5	0.8	0.7	0.1	0.8	-0.5	0.3	-0.1
3.	Clermiston	0.5	1.2	0.5	1.9	-0.7	2.0	0.7	-	0.5	1.8	1.4	-0.8	1.2	0.5	0.3	0.6
4.	Swanston	2.1	1.4	0.4	0.5	0.2	1.4	-0.9	1.2	-0.0	0.1	-0.0	0.7	-0.3	1.1	1.0	-0.4
5.	Wav./Reg.Place	0.3	2.6	0.2	1.3	-0.9	1.9	0.6	5.0	1.7	2.7	0.3	-0.6	0.5	-0.7	0.6	-0.0
6.	Westburn Park	0.4	1.6	-0.4	-0.3	0.3	1.3	1.7	4.6	2.1	1.0	0.2	1.7	-1.1	1.2	1.0	0.2
7.	St Peters Pl.	0.1	1.6	1.0	0.9	-0.2	2.6	-0.1	2.6	-0.1	-0.4	0.5	1.9	0.3	1.4	1.3	1.0
8.	Saughton Mains	1.5	0.8	1.1	1.1	1.3	0.7	-0.9	2.6	0.4	0.8	0.8	0.2	-0.1	-0.2	0.7	-0.3
9.	Craigleith Hill Ave.	0.7	2.0	0.1	1.0	1.4	1.1	-0.4	1.7	0.2	0.1	0.1	0.4	-0.3	0.1	0.7	0.5
10.	Pilton	0.9	1.4	0.5	1.4	0.6	0.6	0.4	3.4	1.0	0.7	0.8	0.4	0.1	0.0	1.1	0.3
11.	Cammo	0.3	1.4	0.9	1.0	0.1	0.9	-2.5	1.4	0.3	1.4	0.0	0.4	-0.9	0.5	1.7	-1.2
12.	Turnhouse	0.2	1.1	-0.4	1.4	-0.0	1.1	-1.1	1.7	0.4	-0.4	0.2	1.1	0.1	1.3	1.4	0.0
13.	Leith	0.3	2.9	-0.5	1.1	-1.3	1.6	1.4	3.4	1.0	1.1	0.6	0.7	-0.5	0.4	1.2	-0.0
14.	Craigleith Cres/View	0.6	0.9	0.4	0.8	1.2	0.8	-2.6	1.4	0.3	1.9	0.7	-0.3	0.1	0.1	0.6	-1.2
15.	Easter Rd/Dalry	-0.5	1.0	0.0	0.4	0.2	0.4	0.9	3.4	0.1	0.7	-0.0	0.9	-0.2	0.2	0.2	-0.1
16.	All Areas																

B = Hours of Week at Store
C = Total Hours/Week
D = Expenditure/Week at Store
E = Total Expenditure/Week
F = Frequency/Week at Store
G = Total Frequency/Week
I = Freezer Ownership
J = No. of Cars
K = Income
L = No. of Licences
M = No. in Household
N = Mean Age in Household
O = S.D. OF Age
P = S.E.G.
Q = Employment
R = Personal Accessibility

TABLE 12

Measure of Skewness for Each Survey Area

The two conceptual models imply a multiple regression analysis, with a preceding identification of principal components in one of the models. The input to these statistical techniques is from a bivariate correlation matrix which serves the additional purpose of indicating the sense and strength of the bivariate variable relationships.

6.11.2 The nature of the relationship between the independent and dependent variables requires to be analysed in detail at various disaggregate and aggregate levels and the proposed canonical correlation analysis will identify the overall strength of the relationship at each level and the structure of that relationship. This will indicate the level of generality of model that can be achieved. It may be that certain groups of areas exhibit the same structural relationship and cluster analysis will be used to identify these groupings.

6.11.3 The chapter then explains the rationale behind the sampling framework, survey area and questionnaire design and this is tested in a pilot survey. Following the pilot survey the organisation of the main survey is explained and the initial tabulation of the raw data.

6.11.4 The final section discusses the initial data characteristics and identifies certain variations between areas. Tables of means, standard deviations and degree of skewness are listed and an initial appreciation of the interdependence of the variables is gained. The means data matrix will be required for the detailed analysis.

6.11.5 The following chapter deals with the analysis of both the proposed models and investigates the nature of the relationship between the independent and dependent variables at area, mean and composite area level. This will enable a generalised trip generation model to be developed which can then be integrated into a standard, aggregate trip distribution model.

CHAPTER 7

ANALYSIS OF THE DATA

7.1 Introduction

This chapter follows on from the preliminary profile analysis of areas and carries out the research tasks, identified from the research objectives and conceptual framework, developed within Chapter 6.

The analysis is divided into three sections :

i) the formation of the Pearson correlation matrices and principal components analysis to develop the conceptual Model 1.

ii) the canonical correlation analysis to analyse the strength and structure of the relationship between the two sets of variables.

iii) the multiple regression analysis to develop a disaggregate trip prediction model.

These tasks not only identify the appropriate form of the trip generation model being proposed but establish the level of disaggregation possible whilst retaining an acceptable level of trip prediction. The proposed model will then be examined for stability and application in the following chapter.

7.2 The Framework of the Analysis

7.2.1 The conceptual framework shown in Figures 11 and 12 identify two models; one based on composite, variable components and the other based on individual variables. One of the primary research tasks is therefore to confirm the component data structure of Model 1. In building a predictive trip generation model for private-car trips to large stores the level of generality that can be attributed to the chosen model must be found. The conceptual framework has shown this in two parts; one at the individual area level and the other at the total area and means area levels. The analysis must examine the structure of the relationship at area, means and total level to identify the level of generality able to be achieved in the model. It may be that although not all the area relationships are the same, groups of areas may be the same and so this is an intermediate level of aggregation that will be examined.

7.2.2 If areal variation exists the analysis must discuss and explain this variation. The initial production of the Pearson bivariate correlation matrix at area, mean and total level will aid this understanding in addition to providing the input matrix for the later stages of the analysis.

7.2.3 Once the level of generality is identified a predictive model can be developed at the appropriate level. The effectiveness of the model and its stability over each individual area will be tested.

7.2.4 The methods of analysis are shown in matrix form in Table 13 and relate to the levels of aggregation and research tasks emanating from the research objectives and conceptual framework of Chapters 3, 4 and 5. It is proposed to separate the analysis and the interpretation

RESEARCH TASKS	INDIVIDUAL AREA LEVEL	MEAN OF AREAS LEVELS	TOTAL OF ALL AREAS LEVEL
Compute the correlation matrices for the input to the statistical techniques used later in the analysis. Preliminary investigation of bivariate relationships as an aid to understanding and interpretation later in the analysis.	Compute Correlation Matrix	Compute Correlation Matrix	Compute Correlation Matrix
	Test for area non-homogeneity	Test for area non-homogeneity	Test for area non-homogeneity
Identify the Employment, Household Structure and Lifestyle factors of Model 1	Principal components analysis and discussion of structure of components - Model 1.	Principal components analysis, with and without spatial accessibility index and discussion of structure of components - Model 1.	Principal components analysis with discussion of structure of components - Model 1. Test of non-homogeneity by addition of areas on aggregate component structure.
Examine and analyse the strength and structure of the relationship between the dependent and independent variables at at individual area, aggregated areas and means of areas levels. Determine the level of generality than can be achieved by the models.	Canonical correlation analysis to determine form and strength of relationship between dependent and independent variables.	Canonical correlation analysis to determine form and strength of relationship between dependent and independent variables.	Canonical correlation analysis to determine form and strength of relationship between dependent and independent variables Test of stability, by addition of areas of canonical variate structure.
	Canonical correlation analyses using only the store variables with all independent and three independent variables.	Canonical correlation analyses using only the store variables with all independent and three independent variables.	Canonical correlation analyses using only the store variables with all independent and three independent variables.
		Explanation of Areal variation with respect to Pearson correlation matrices.	
			Explanation of groupings of areas using cluster analysis.
Build a predictive trip generation model for private car trips to large foodstores.	Multiple Regression Analysis - Models 1 and 2	Multiple Regression Analysis - Models 1 & 2. Model 2 carried out in three stages: 1) with all independent variables 2) without personal accessibility (R) 3) as (2) and without income (K) and freezer ownership(I).	Multiple Regression Analysis - Models 1 & 2. Model 2 carried out in four stages: 1) all six dependent variables with individual independent variables. 2) three store variables and and three independent components w.r.t. total data matrix. 3) three store variables and three independent components w.r.t. individual areas. 4) three store variables and three independent components w.r.t. means data matrix.

TABLE 13

Table of Analytical Methods with Respect to Identified Research Tasks of the results so that this chapter will report on the analysis. The following chapter will then interpret the findings from the analysis. It is difficult to achieve a complete segregation of analysis and interpretation and certain points of interpretation will be discussed as they occur in this chapter.

7.3 Calculation of Pearson Product-Moment Correlations Matrix and Identification of Significant Variable Correlations with respect to the Conceptual Framework

7.3.1 Pearson Correlation Coefficients with respect to the Dependent Variables

The Pearson correlation coefficients, greater than or equal to 0.35, for the dependent variables are listed in Table 14. All correlation coefficients listed with respect to dependent and independent variables are statistically significant at the 5% level.

The table shows that the three store usage variables are strongly intercorrelated in all areas, the exception being in area 11 (Cammo) between duration of stay and frequency of visit to the stores. The three total shopping usage variables are also strongly intercorrelated although the strength of the correlation varies from area to area. The significant relationship between store and total shopping usage relates to the shopping expenditure variables D and E. Area 1 (Moredun) and Area 13 (Leith) are the exceptions. Area 1 is an area remote from large shopping stores with a large retired persons grouping and Area 13 is an inner city area of low income and car ownership.

No relationship was found between duration of stay at the stores and total time spent shopping. This also applied to frequency of visit to large stores. In general the households regarded the bulk-buying shopping usage as a separate entity from other household shopping.

Variable Relationships		Moredun	Spottiswoode	Clermiston	Swanston	Waverley	Westburn	St Peters	Saughton	Craigleith H	Pilton	Cammo	Turnhouse	Leith	Craigleith	Easter	Total
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Hrs/Week at Store(B)	Total Shopping Hrs/Weeks (C)	-	-	0.48	-	-	-	-	-	0.57	-	-	0.41	-	-	-	-
Hrs/Week at Store(B)	Exp/Week at Store(D)	0.78	0.52	0.66	0.76	0.66	0.62	0.80	0.78	0.68	0.77	0.40	0.71	0.55	0.81	0.58	0.67
Hrs/Week at Store(B)	Tot.Shopping Exp./Week(E)	-	-	-	0.7	-	0.57	0.40	-	0.40	-	-	0.60	-	0.42	-	-
Hrs/Week at Store(B)	Freq./Week at Store(F)	0.92	0.82	0.82	0.78	0.68	0.88	0.88	0.93	0.83	0.94	-	0.72	0.77	0.83	0.57	0.78
Hrs/Week at Store(B)	Tot.Freq./ Week (G)	-	-	-	-	-	-	0.40	-	-	-	0.40	-	-	-	-	-
Tot.Shopping Hrs/Week(C)	Exp./Week at Store(D)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tot.Shopping Hrs/Week(C)	Tot.Shopping Exp./Week(E)	0.40	-	0.53	0.45	0.81	-	0.44	0.58	-	0.42	-	0.60	0.71	0.54	0.56	0.44
Tot.Shopping Hrs/Week(C)	Freq./Week at Store(F)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tot.Shopping Hrs/Week(C)	Tot.Freq./ Week (G)	0.80	0.73	0.71	0.69	0.88	0.88	0.48	0.88	0.70	0.74	-	0.75	0.87	0.79	0.84	0.73
Exp./Week at Store(D)	Tot.Shopping Exp./Week(E)	-	0.46	0.65	0.58	0.42	0.85	0.63	0.61	0.59	0.58	0.91	0.74	-	0.64	0.51	0.57
Exp.Week at Store(D)	Freq./Week at Store (F)	0.89	0.48	0.81	0.74	0.62	0.65	0.84	0.74	0.86	0.50	0.81	0.85	0.82	0.62	0.62	0.76
Exp./Week at Store(D)	Tot.Freq./ Week(G)	-0.38	-0.64	-	-	-	-0.42	-	-	-	-	-	-	-	-	-	-
Tot.Shopping Exp./Week(E)	Freq./Week at Store(F)	-	-	-	-	-	0.56	-	-	0.45	-	0.45	0.61	-	0.52	-	-
Tot.Shopping Exp./Week(E)	Tot.Freq./ Week (G)	-	-	0.73	0.48	0.83	-	0.45	0.52	0.45	0.55	-	0.56	0.86	0.40	0.64	0.47
Freq./Week at Store(F)	Tot.Freq./ Week(G)	-0.49	-	-	-	-	-0.45	-	-	-	-	-	-	-	-	-	-

NOTE: 1) Only coefficients greater than 0.35 are shown.
2) All coefficients are statistically significant at the 5% level.

TABLE 14

Pearson Correlation Coefficients Between Dependent Variables

7.3.2 Pearson Correlation Coefficients with respect to the Independent Variables

As with the dependent variables only coefficients greater than 0.35 and significant at the 5% level are shown. Table 15 shows the listings of coefficients. Variable H (House Type) has been omitted from the analysis because of collinearity problems with other independent variables. This is not of concern because each area showed little variation in house type and this variable would not have added significantly to the analysis.

Inspection of the table indicates that income, the household structure variables, employment and socio-economic grouping are the variables showing the strongest intercorrelations with other independent variables. Certain areas diverge significantly from the general correlations. Areas 12 (Turnhouse) and 1 (Moredun) show particular divergence. Area 1 shows this divergence with the dependent variables and its contributing factors were highlighted in the previous subsection. Area 12 is a remote suburb on the City boundary and is predominantly young, middle-class families. The separation of the area from the other parts of the City may contribute to the devergent nature of the area. It will be noted that the personal accessibility variable (R) does not show a consistently strong correlation with any other variable although it is negatively correlated with income and employment and positively correlated with the mean age of the household and socio-economic grouping.

Variable Relationships		Moredun 1	Spottiswood. 2	Clermiston 3	Swanston 4	Waverley 5	Westburn 6	St Peters 7	Saughton 8	Craiglieth 9	Pilton 10	Cammo 11	Turnhouse 12	Leith 13	Craigleith 14	Easter 15	Total 16
Freezer Ownership(I)	Income(K)	-	0.49	0.38	0.57	-	-	0.60	-	0.39	-	-	-	0.42	0.36	-	0.37
No. of Cars(J)	Income(K)	0.49	0.41	-	0.55	0.73	-	0.50	-	0.43	0.47	0.70	-	0.72	0.60	-	0.53
No. of Cars(J)	No. of Licences(L)	-	-	-	0.38	0.84	-	0.33	-	0.59	-	0.88	-	-	0.62	-	0.51
No. of Cars(J)	Employment(Q)	-	0.52	-	-	0.42	0.47	0.52	-	0.43	0.48	0.82	-	-	0.64	0.52	-
Income(K)	No. of Licences(L)	-	0.58	-	0.64	0.72	-	0.44	0.61	0.47	-	0.57	-	-	0.58	-	0.53
Income(K)	No. in Household(M)	-	-	-	-	0.56	-	0.42	0.79	0.53	-	0.68	0.36	-	0.65	0.65	0.40
Income(K)	Mean Age of Household(N)	-0.46	-0.53	-0.40	-	-0.57	-0.38	-	-0.70	-0.63	-	-0.35	-	-0.40	-0.61	-0.60	-0.37
Income(K)	S.D. OF Household Ages(O)	-	-	-	-	0.65	0.42	0.52	0.61	0.61	-	0.40	-	-	0.60	0.59	0.36
Income(K)	S.E.G. (P)	-0.80	-0.57	-0.61	-0.55	-0.70	-	-0.55	-0.59	-0.77	-	-0.67	-	-0.64	-0.71	-0.57	-0.59
Income(K)	Employment(Q)	-	0.70	0.43	0.53	0.64	-	0.52	0.87	0.68	0.82	0.71	0.41	0.52	0.65	0.49	0.52
Income(K)	Personal Accessibility(R)	-0.49	-	-0.54	-	-0.40	-0.41	-	-0.53	-	-	-0.46	-	-	-0.37	-	-
No. of Licenses(L)	No. in Household(M)	-	0.67	-	-	0.45	-	0.46	0.48	0.48	0.44	0.57	-	0.33	0.65	-	0.38
No. of Licences(L)	S.D. of Household Ages(O)	-	0.55	0.46	-	0.47	-	-	-	0.61	0.35	0.59	-	-	0.64	-	0.36
No. of Licences(L)	Employment(Q)	-	0.53	0.38	-	0.52	-	0.54	0.53	0.44	-	0.91	-	0.53	0.46	-	0.39
No. in Household(M)	Mean Age of Household(N)	-0.64	-0.48	-0.74	-0.73	0.87	-0.55	-	-0.79	-0.81	-0.69	-0.79	-0.42	-0.77	-0.87	-0.49	-0.62
No. in Household(M)	S.D. of House hold Ages(O)	0.84	0.89	0.78	0.73	0.79	0.62	0.72	0.69	0.78	0.75	0.67	0.66	0.52	0.80	0.79	0.72

NOTE: 1) Only coefficients greater than 0.35 are shown.
2) All coefficients are statistically significant at the 5% level.

TABLE 15 (Part One)

Pearson Correlation Coefficients Between Independent Variables

Variable Relationships	Areas	Moredun 1	Spottiswoode 2	Clermiston 3	Swanston 4	Waverley 5	Westburn 6	St Peters 7	Saughton 8	Craigleith Hill 9	Pilton 10	Cammo 11	Turnhouse 12	Leith 13	Craigleith 14	Easter 15	Total 16
No. in Household(M)	S.E.G. (P)	-0.46	-	-	-	-0.62	-0.48	-	-0.51	-0.39	-	-0.78	-	-0.38	-0.64	-0.62	-0.35
No. in Household(M)	Employment(Q)	-	0.56	0.62	0.46	0.78	0.67	-	0.78	0.77	0.38	0.60	-	0.45	0.48	0.39	0.48
Mean Age of H/hold Ages(N)	S.D. of Household Ages(O)	-0.51	-0.45	-0.64	-0.65	-0.85	-0.55	-	-0.68	-0.81	-0.69	-0.71	-	-0.63	-0.81	-0.50	-0.57
Mean Age of H/hold Ages (N)	S.E.G. (P)	0.79	0.64	0.40	0.47	0.73	0.82	-	0.68	0.67	0.38	0.77	0.37	0.59	0.70	0.73	0.60
Mean Age of H/hold Ages (N)	Employment (Q)	-	-0.63	-0.63	-0.41	-0.82	-0.52	-	-0.73	-0.68	-0.39	-0.42	-	-0.45	-0.55	-0.68	-0.45
Mean Age of H.Hold Ages(N)	Personal Accessibility (R)	0.47	0.57	0.40	-	0.67	0.38	0.40	0.43	0.40	-	-	-0.41	-	-	0.47	-
S.D. of Household Ages(O)	S.E.G. (P)	-	-	-0.36	-	-0.69	-	-	-0.41	-0.53	-	-0.50	-	-0.40	-0.49	-0.68	-0.35
S.D. of Household Ages(O)	Employment(Q)	-	0.54	0.54	-	0.81	0.51	-	0.60	0.71	-	0.57	-	0.47	0.52	0.56	0.40
S.E.G.(P)	Employment(Q)	-	-0.56	-0.63	-	-0.81	-0.56	-0.36	-0.64	-0.53	-	-0.60	-	-0.56	-0.81	-0.61	-0.47
S.E.G.(P)	Personal Accessibility(R)	0.68	0.52	0.68	-	0.60	-	-	0.52	0.45	0.40	0.35	-	0.51	0.35	0.41	-
Employment(Q)	Personal Accessibility(R)	-	-	-0.61	-0.46	-0.67	-	-	-0.58	-0.41	-0.40	-0.62	-	-0.56	-0.61	-0.62	-0.41

TABLE 15 (Part Two)

Pearson Correlation Coefficients Between Independent Variables

7.3.3 Pearson Correlation Coefficients with respect to the Relationships between Dependent and Independent Variables

The correlation coefficients, greater than or equal to 0.35, between the dependent and independent variables are shown in Table 16. Three values just below 0.33 are shown in brackets and all values shown are significant at the 5% level.

These relationships are of prime importance to the study as they indicate the strengths of the linear relationships between the predictor and predicted variables. It is evident, from Table 16, that the large store and total shopping expenditure variables (D and E) are the most important of the dependent variables and show correlation with the same independent variables discussed in the previous section i.e. income, the household structure variables and employment. Socio-economic grouping does not appear. Again areas 1 (Moredun) and 12 (Turnhouse) consistently do not show these relationships and in addition area 4 (Swanston) shows little relationship between the two sets of variables. Area 4 is similar to area 12 in that it is an outer, middle-class suburb.

The correlation coefficients for the sum of all the areas combined are low, the highest being 0.57 between total shopping expenditure per week and the number in the household, which is not unexpected due to the areal variability.

7.3.4 These initial results show areal variation in the bivariate correlations and will be important in the interpretation of this variation. Some of the variation can be attributed to the location or a dominant characteristic in the area, such as high mean age of population or proximity to a large store, and it is expected that in general the areal variation will be shown

Variable Relationships	Areas	Moredun 1	Spottiswoode 2	Clermiston 3	Swanston 4	Waverley 5	Westburn 6	St Peters 7	Saughton 8	Craigleith Hill 9	Pilton 10	Cammo 11	Turnhouse 12	Leith 13	Craigleith 14	Easter 15	Total 16
Exp./Week at Store(D)	Income(K)	-	0.47	0.43	-	-	-	0.45	-	0.49	0.39	0.65	-	-	-	-	0.36
Exp./Week at Store(D)	No. in Household(M)	-	0.40	-	-	0.39	0.60	0.40	(0.33)	0.71	0.42	0.66	-	-	-	-	(0.33)
Exp./Week at Store(D)	Stand.Dev.of H/hold Ages(O)	-	-	-	-	-	0.57	0.41	0.36	0.58	0.42	0.35	-	-	0.43	-	-
Exp./Week at Store(D)	Employment(Q)	-	0.43	-	-	0.43	0.55	-	-	0.51	0.39	0.79	-	-	-	-	-
Tot.Shopping Exp./Week(E)	No. in Household(M)	0.50	-	0.70	-	0.59	0.81	0.56	0.73	0.60	0.62	0.71	0.52	0.45	0.53	0.78	0.57
Tot.Shopping Exp./Week(E)	Mean Age of Household(N)	-0.43	-0.63	-0.60	-	-0.45	-0.55	-	-0.63	-0.57	-0.49	-0.43	-	-0.34	-0.50	-0.39	-0.39
Tot.Shopping Exp./Week(E)	S.D. of Ages(O)	-	-	0.43	-	0.34	0.73	0.35	0.41	0.57	0.60	0.52	0.37	0.49	0.61	0.72	0.43
Tot.Shopping Exp./Week(E)	Employment(Q)	-0.37	0.73	0.64	-	0.48	0.72	-	0.56	0.51	0.55	0.74	-	0.43	-	-	0.42
Tot.Shopping Freq./Week(G)	No. in Household(M)	-	-	0.58	0.35	0.41	-	-	0.46	-	0.41	-	0.50	0.38	-	0.67	(0.31)

TABLE 16

Pearson Correlation Coefficients Relating Dependent and Independent Variables to be the result of several local area effects working together. These initial indications do not encourage the development of a generalised model for all areas at household level. In particular areas 1 and 12 cause concern in that they consistently diverge from the general pattern. This effect may continue to be seen in the statistical analysis of each area's data.

7.4 Testing the Areal Data for Non-Homogeneity of the Bivariate Correlations

7.4.1 The tables showing the significant bivariate correlations also show an areal variation. It is important, in the context of a generalised model, to establish whether these areal variations mean that these areas constitute a non-homogenous group. To test this each variable pair was pooled over the fifteen areas and the resulting single correlation compared to the bivariate correlation obtained from the total data matrix for the same variable pair. The homogeneity of each variable pair was then tested using a computer program based on the parallel estimates of correlation coefficients. The method of averaging is via the Z-transformation procedure.[122] The bivariate comparisons are listed in Table 17. The variable pairs with a correlation coefficient greater than 0.3 were subjected to a further analysis. The most divergent area was omitted first and the new whole correlation coefficient compared to the total matrix coefficient. If this did not establish homogeneity between the groups the next most diverse area was omitted. This process continued until homogeneity was achieved. Table 18 shows the selected variable pairs and the areas omitted in order to achieve homogeneity.

7.4.2 The table shows that where homogeneity exists in a variable pair over all areas the pooled correlation

B - C	0.1500	(0.2144)
B - D	0.6706	(0.6947)
B - E	0.2331	(N.H.)
B - F*	0.7816	(N.H.)
B - G	-0.1067	(-0.1373)
B - H	0.0316	(0.0795)
B - I	0.0658	(0.0827)
B - J	0.0258	(0.0182)
B - K	0.0507	(0.0325)
B - L	0.0472	(0.0001)
B - M	0.0750	(0.0673)
B - N	-0.0942	(-0.1127)
B - O	0.0483	(0.0247)
B - P	-0.0432	(-0.0327)
B - Q	-0.0734	(-0.0595)
B - R	0.0574	(0.0302)
C - D	-0.0647	(-0.0166)
C - E*	0.4457	(N.H.)
C - F	-0.0040	(0.0507)
C - G*	0.7336	(N.H.)
C - H	0.0725	(-0.0410)
C - I	0.0050	(0.0491)
C - J	-0.0868	(-0.0642)
C - K	-0.0489	(0.0018)
C - L	-0.0057	(0.0223)
C - M	0.2574	(0.2686)
C - N	-0.0964	(N.H.)
C - O	0.1841	(0.1857)
C - P	0.0216	(-0.0252)
C - Q	0.0366	(0.0337)
C - R	-0.0006	(0.0238)
D - E*	0.5721	(N.H.)
D - F	0.7562	(0.7676)
D - G	-0.1421	(-0.1740)
D - H	-0.0220	(0.0675)
D - I	0.2131	(0.2049)
D - J	0.2315	(N.H.)
D - K	0.3555	(0.3201)
D - L	0.2865	(N.H.)
D - M	0.3304	(N.H.)
D - N	-0.2963	(-0.3017)
D - O	0.2656	(N.H.)
D - P	-0.2211	(-0.1970)
D - Q	0.2396	(N.H.)
D - R	-0.0177	(-0.0717)
E - F	0.3007	(N.H.)
E - G*	0.4370	(N.H.)
E - H	0.0444	(0.1021)
E - I	0.1766	(0.1484)
E - J	0.1895	(N.H.)
E - K	0.4032	(N.H.)
E - L	0.2477	(N.H.)
E - M*	0.5731	(N.H.)
E - N*	-0.3780	(N.H.)
E - O	0.4255	(0.4531)
E - P*	-0.2783	(N.H.)
E - Q*	0.4216	(N.H.)
E - R	-0.0928	(N.H.)
F - G	-0.0620	(-0.0913)
F - H	0.0300	(0.1265)
F - I	0.0956	(0.0828)
F - J	0.1006	(0.0702)
F - K	0.1754	(0.1047)
F - L	0.1101	(0.0039)
F - M	0.1446	(0.0868)
F - N	0.1636	(-0.1292)
F - O	0.1162	(0.0401)
F - P	-0.1132	( )
F - Q	-0.0196	(-0.0247)
F - R	0.0441	(-0.0034)
G - H	0.0713	(N.H.)
G - I	0.0090	(N.H.)
G - J	-0.0282	(-0.0388)
G - K	0.0275	(0.0896)
G - L	0.0035	(0.0301)
G - M	0.3106	(0.3458)
G - N	0.1153	(N.H.)
G - O	0.1756	(0.2229)
G - P	0.0180	(-0.0620)
G - Q	0.1159	(0.1595)
G - R	0.0089	(0.0270)
H - I	0.2362	(-0.1621)
H - J	0.1654	(-0.0987)
H - K	-0.2162	(-0.1619)
H - L	-0.1712	(-0.0973)
H - M	0.0104	(-0.0394)
H - N	0.0010	(-0.0705)
H - O	-0.0910	(-0.0881)
H - P	0.1951	(0.1839)
H - Q	0.0585	(-0.0207)
H - R	-0.1388	(-0.0728)
I - J	0.2913	(0.2389)
I - K	0.3720	(0.2734)
I - L	0.2678	(0.1725)
I - M	0.1693	(0.1949)
I - N	-0.0836	(-0.1321)
I - O	0.1714	(0.1746)
I - P	-0.2038	(-0.1752)
I - Q	0.1758	(0.1892)
I - R	-0.0113	(-0.1117)
J - K*	0.5313	(N.H.)
J - L*	0.5059	(N.H.)
J - M	0.2213	(0.2316)
J - N	0.1033	(-0.1030)
J - O	0.2481	(0.2432)
J - P	0.3132	(-0.2443)
J - Q	0.3292	(N.H.)
J - R	0.0180	(-0.0429)
K - L	0.5261	(N.H.)
K - M*	0.3981	(N.H.)
K - N	-0.3650	(-0.4308)
K - O*	0.3637	(N.H.)
K - P	-0.5949	(-0.5839)
K - Q*	0.5220	(N.H.)
K - R	-0.1771	(-0.3246)
L - M	0.3763	(0.3754)
L - N	-0.2905	(-0.2612)
L - O*	0.3593	(N.H.)
L - P	-0.3766	(-0.2880)
L - Q*	0.3905	(N.H.)
L - R	0.0945	(N.H.)
M - N*	-0.6219	(N.H.)
M - O	0.7157	(0.7479)
M - P*	-0.3482	(N.H.)
M - Q*	0.4846	(N.H.)
M - R*	0.1216	(-0.0807)
N - O*	-0.5714	(N.H.)
N - P*	0.5975	(N.H.)
N - Q*	-0.4511	(N.H.)
N - R*	0.3182	(N.H.)
O - P	-0.3467	(-0.3758)
O - Q*	0.4047	(N.H.)
O - R	-0.315	(-0.1732)
P - Q*	0.4682	(N.H.)
P - R*	0.3139	(N.H.)
Q - R*	-0.4115	(N.H.)

KEY:

N.H. - Not Homogeneous
* - Selected for Further Analysis

TABLE 17

Homogeneity Test For Each Variables Pair - Comparing Area "Pooled" Correlation with Total Matrix Correlation

Variable Pairing			Total Matrix Coefficient	Pooled Coefficient (All Areas)	Remarks
Hrs./Wk at Store (B)	-	Freq./Wk at Store(F)	0.78	Not Homogeneous	By omitting areas Cammo(11) and Easter (15) homogeneity was achieved giving a whole factor of 0.85.
Tot.Hrs/Wk Shopping(C)	-	Tot.Exp./Wk Shopping(E)	0.45	Not Homogeneous	By omitting Spottiswoode(2) homogeneity was achieved giving a whole factor of 0.51.
Tot.Hrs/Wk Shopping(C)	-	Tot.Freq./Wk Shopping(G)	0.73	Not Homogeneous	By omitting Cammo(11) homogeneity was achieved giving a whole factor of 0.51.
Exp./Wk at Store(D)	-	Tot.Exp./Wk Shopping(E)	-0.57	Not Homogeneous	By omitting areas Moredun (1) and Leith(13) homogeneity was achieved giving a whole factor of -0.65.
Tot.Exp./Wk Shopping(E)	-	Tot.Freq./ Weeks(G)	-0.47	Not Homogeneous	By ommitting areas Spottiswoode(2), Westburn(6) and Cammo(11) homogeneity was achieved giving a whole factor of -0.60.
Tot.Exp./Wk Shopping(E)	-	No. in Household(M)	-0.57	Not Homogeneous	By omitting area Swanston (4) homogeneity was achieved giving a whole factor of -0.62.
Tot.Exp./Wk Shopping(E)	-	Mean Age of Household(N)	-0.38	Not Homogeneous	By omitting area St Peters (7) homogeneity was achieved giving a whole factor of -0.45.

TABLE 18

Testing for Areal Homogeneity with Selected Variable Pairs

Variable Pairing			Total Matrix Coefficient	Pooled Coefficient (All Areas)	Remarks
Tot.Exp. /Week(E)	-	Employment/ Household(Q)	0.42	Not Homogeneous	By omitting areas Moredun (1) and Craigleith(14) homogeneity was achieved giving a whole factor of 0.49.
Exp./Wk at Store(D	-	No. in Household(M)	0.33	Not Homogeneous	By omitting areas Moredun (1) and Swanston(4) homogeneity was achieved giving a whole factor of 0.37.
No. of Cars/ Household(J)	-	Income(K)	0.53	Not Homogeneous	By omitting area Easter(15) homogeneity was acheived giving a whole factor of 0.50.
No. of Cars/ Household	-	No. of Lic. Holders(L)	0.51	Not Homogeneous	Homogeneity could not be achieved after four groups had been omitted.
Income/ Household(K)	-	No. in Household(M)	0.40	Not Homogeneous	By omitting area Clermiston (3) homogeneity was achieved giving a whole factor of 0.48.
Income/ Household(K)	-	S.D. of Ages(O)	0.36	Not Homogeneous	By omitting area Turnhouse (12) homogeneity is achieved giving a whole factor of 0.40.
Income/ Household(K)	-	Employment/ Household(Q)	0.52	Not Homogeneous	By omitting areas Moredun (1) and Westburn (6) homogeneiry is achieved giving a whole factor of 0.63.
No.of Lic. Holders(L)	-	S.D. of Aes(O)	0.39	Not Homogeneous	By omitting areas Moredun (1) and Easter(15) homogeneity is achieved giving a whole factor of 0.48.

TABLE 18 (Contd)

Variable Pairing		Total Matrix Coefficient	Pooled Coefficient (All Areas)	Remarks
No. in Household(M) -	Mean Age of Household(Q)	-0.62	Not Homogeneous	By omitting areas St Peters (7) and Turnhouse(12) homogeneity is achieved giving a whole factor of -0.74.
No. in Household(M) -	S.E.G. of Household(P)	-0.35	Not Homogeneous	By omitting area Pilton(10) homogeneity is achieved giving a whole factor of -0.45.
No. in Household(M) -	Employment/ Household(Q)	0.48	Not Homogeneous	By omitting areas Moredun (1) and Turnhouse(12) homogeneity is achieved giving a whole factor of 0.58.
Mean Age of Household(N) -	S.D. of Ages(O)	-0.57	Not Homogeneous	By omitting areas St Peters (7) and Turnhouse(12) homogeneity is achieved giving a whole factor of -0.67.
Mean Age of Household(N) -	S.E.G. of Household(P)	0.60	Not Homogeneous	By omitting area St Peters (7) homogeneity is achieved giving a whole factor of 0.64.
Mean Age of Household(N) -	Employment of Household(Q)	-0.45	Not Homogeneous	By omitting areas Moredun (1) St Peter(7) and Turnhouse(12) homogeneity is achieved giving a whole factor of -0.60.
Mean Age of Household(n) -	Personal Access.(R)	0.32	Not Homogeneous	By omitting areas Swanston (4), Turnhouse(12) and Craigleith(14) homogeneity was acheived giving a whole factor of 0.42. All these areas have inverse relationships.
S.D. of Ages(O) -	Employment/ Household(Q)	0.40	Not Homogeneous	By omitting areas Moredun (1) and Turnhouse (12)homogeneity was acheived giving a whole factor of 0.52.

TABLE 18 (Contd.)

Variable Pairing		Total Matrix Coefficient	Pooled Coefficient (All Areas)	Remarks
S.E.G. of Household(P) -	Employment/ Household(Q)	-0.47	Not Homogeneous	By omitting area Moredun (1) homogeneity was achieved giving a whole factor of -0.55.
S.E.G OF Household(P) -	Personal Access.(R)	0.31	Not Homogeneous	By omitting areas Swanston (4) and Turnhouse(12) homo-geneity was achieved giving giving a whole factor of 0.46. These areas have a negative relationship.
Employment/ Household(Q) -	Personal Access.(RO	-0.41	Not Homogeneous	By omitting area Moredun(1) homogeneity was acheived giving a whole factor of -0.48.

TABLE 18 (Contd.)

coefficient and the total data matrix coefficient are the same. The occurrence of non-homogeneity can be shown on an area basis and, within areas, on a variable pair basis. Table 19 shows the number of times an area was responsible for causing non-homogeneity over all areas. This highlights area 1 (Moredun) and area 12 (Turnhouse) as those areas showing the greatest tendency to exhibit non-homogeneity and area 4 (Swanston) and area 7 (St Peters) to be the areas showing non-homogeneity four and five times respectively. The first three areas have been described previously but area 7 is a young, middle-class area in the inner city with a large proportion of households with no children and both husband and wife working.

7.4.3 If the variable pairs causing non-homogeneity are listed for each of the above four areas, household structure variables occur in all but two of the variable pairs in areas 4, 7, and 12 and the employment variable occurs in all but three of the variable pairs in area 1. Table 20 lists these variable pairs. Before commenting on these relationships, further investigation to establish the nature of the relationships is undertaken using scatter diagrams. Typical examples of these plots are shown in Figures 20, 21 and 22. The remaining diagrams are shown in Appendix F.

7.4.4 The main points to emerge from these plots is the effect of non-use of the large store and the effect of the category variables. In Figure 20 the linear relationship is impaired by the presence of seven households who do not bulk-buy. The employment variable, although not classified in categories, occurs in categories, as is evident in Figure 21. This effect also occurs with the number in the household, the number of licences in the household and personal accessibility.

Area Number	No. of Time(s) Area was responsible for non-homogeneity
1	11
2	2
3	1
4	4
5	0
6	2
7	5
8	0
9	0
10	1
11	3
12	8
13	1
14	2
15	3

TABLE 19

Occurrence of Non-Homogeneity by Area

AREA 1 :	Expenditure/Week at Store	&	Total Shopping Expenditure/Week
(Moredun)	Total Shopping Expenditure/Week	&	Employment Household
	Expenditure/Week at Store	&	Number in Household
	Income/Household	&	Employment/Household
	No. of Licence Holders	&	S.D. of Ages
	No. of Licence Holders	&	Employment/Household
	No. in Household	&	Employment/Household
	No. in Household	&	Employment/Household
	Mean Age of Household	&	Employment/Household
	S.D. of Ages	&	Employment/Household
	S.E.G. of Household	&	Employment/Household
	Personal Accessibility	&	Employment/Household
AREA 12 :	Income/Household	&	S.D. of Ages
(Turnhouse)	No. in Household	&	Mean Age of Household
	No. in Household	&	Employment/Household
	S.D. of Ages	&	Mean Age of Household
	Mean Age of Household	&	Employment/Household
	Mean Age of Household	&	Personal Accessibility
	S.D. of Ages	&	Employment/Household
	S.E.G. of Household	&	Personal Accessibility
AREA 4 :	Total Shopping Expenditure/Week	&	No. in Household
(Swanston)	Expenditure/Week at Store	&	No. in Household
	Mean Age of Household	&	Personal Accessibility
	S.E.G. of Household	&	Personal Accessibility
AREA 7 :	Total Shopping Expenditure/Week	&	Mean Age of Household
(St Peters)	No. in Household	&	Mean Age of Household
	S.D. of Ages	&	Mean Age of Household
	S.E.G. of Household	&	Mean Age of Household
	Employment/Household	&	Mean Age of Household

TABLE 20

Variable Pairs in Areas Showing Non-Homogeneity

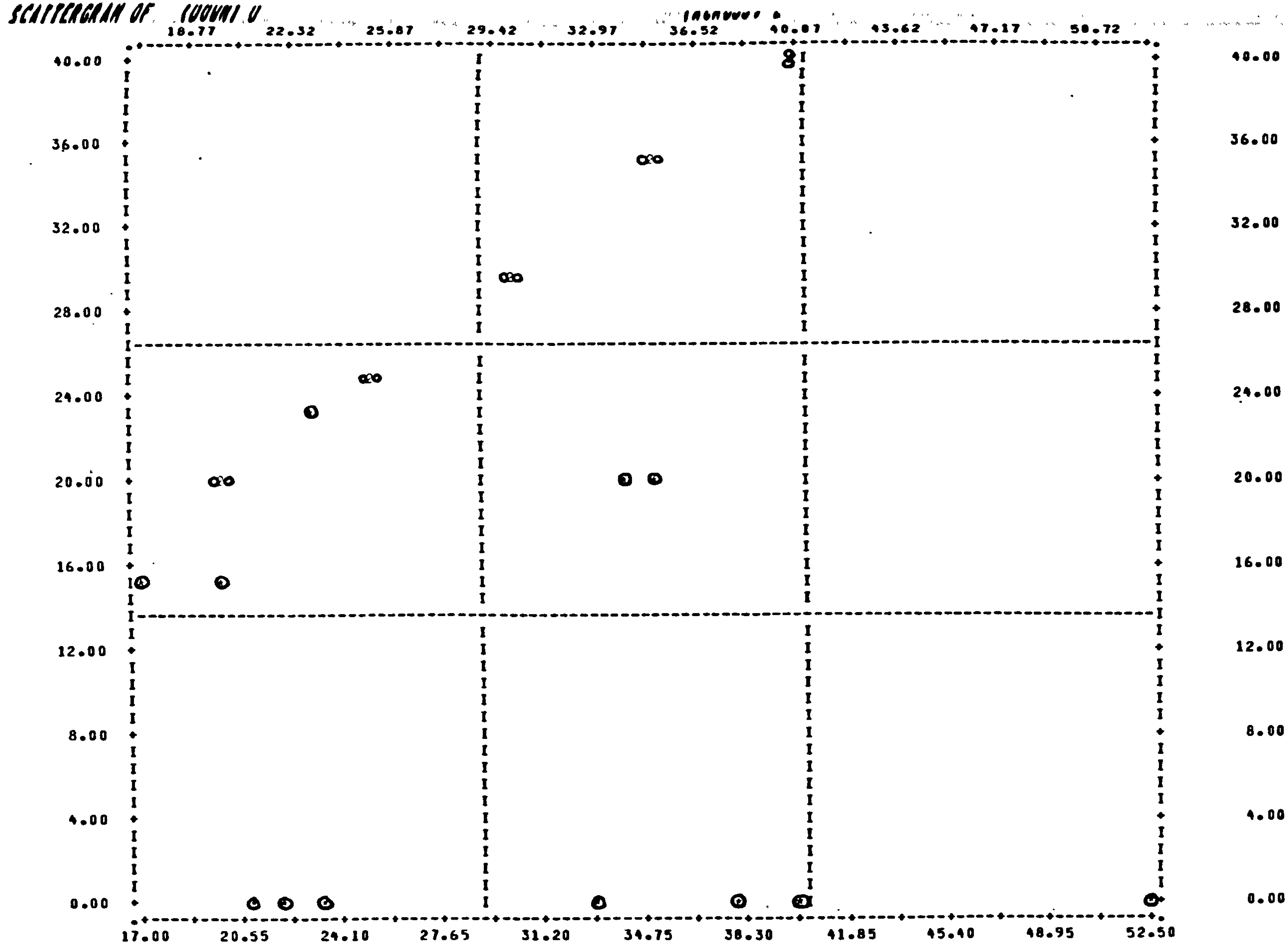


FIGURE 20

Scattergram of the Store Expenditure/Week (D) v. Total Expenditure (E) - Area 1 (Moredun)

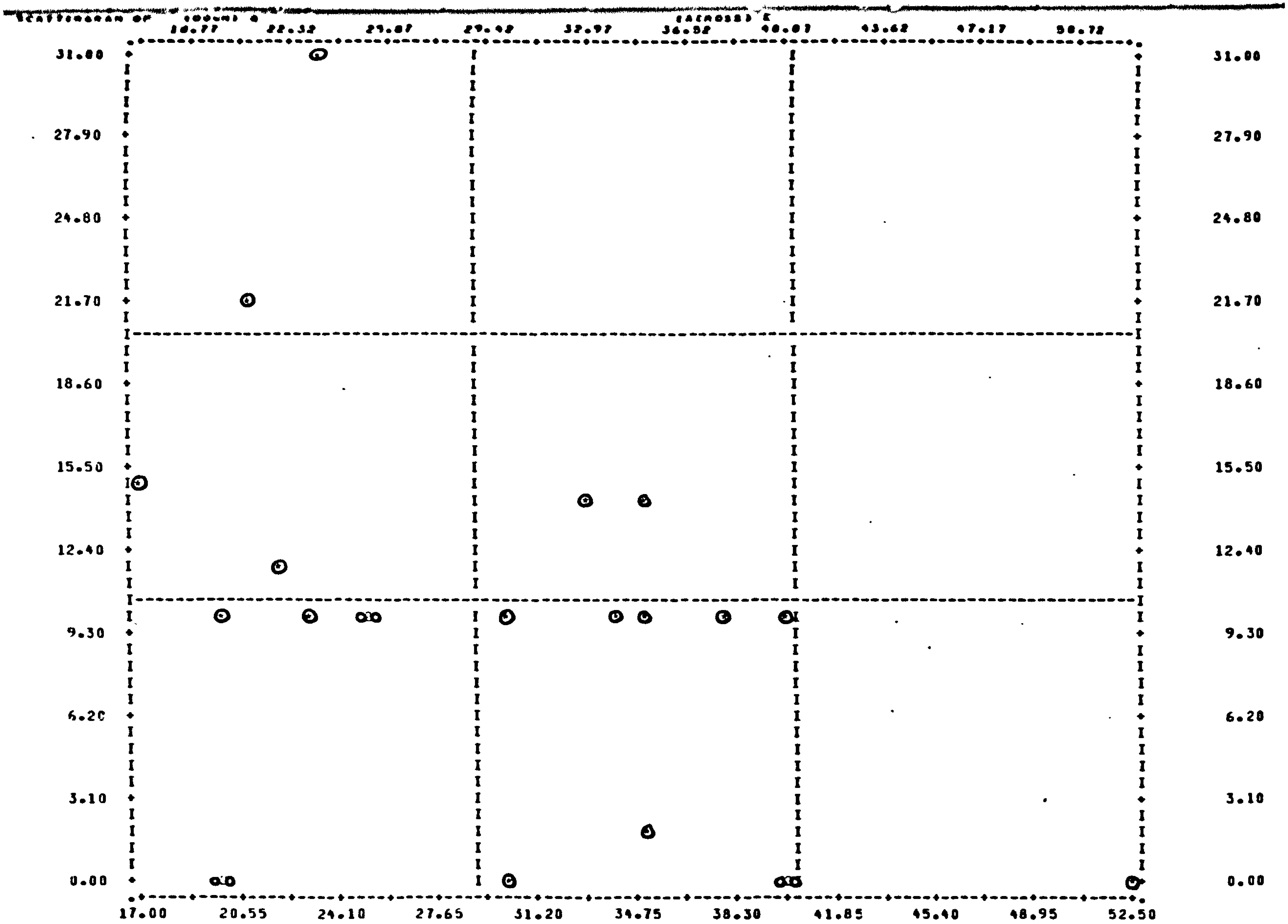


FIGURE 21

Total Expenditure/Week (E) v. No. of Half Days Employed (Q) - Area 1 (Moredun)

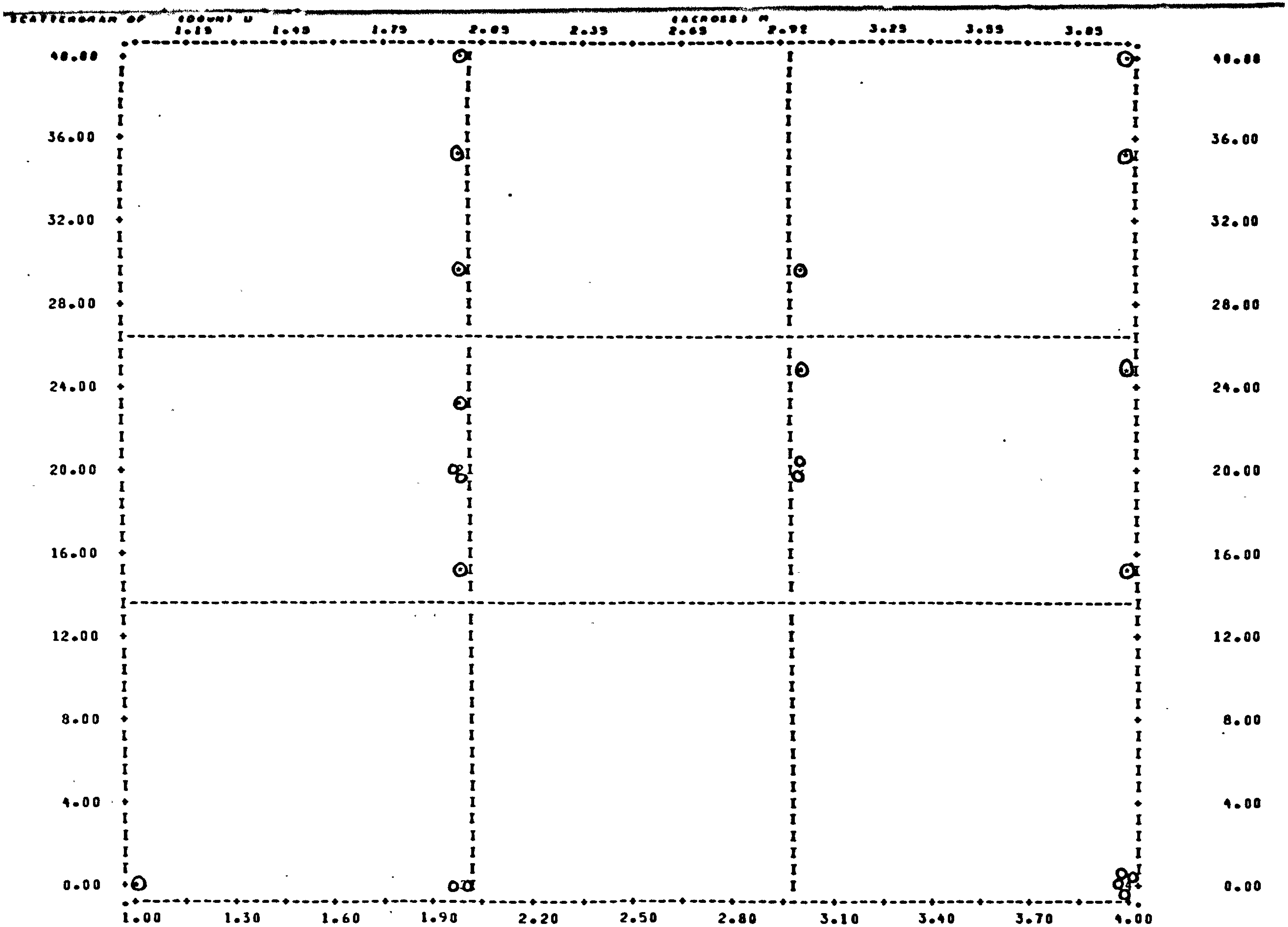


FIGURE 22

Expenditure/Week at Store (D) v. No. in Household (M) - Area 1 (Moredun)

Appendix F-12 shows seven households with zero standard deviation of household ages indicating either one or two persons of the same age residing in the house. Appendix F-21 shows a large group of single persons and young couples with no children, as previously described in area 7. This is also seen in Appendices F-23 and F-24.

In area 1 (Moredun) twenty-five percent of households do not bulk-buy but low usage of large stores in other areas has not resulted in the non-homogeneity present in this area.

7.4.5 The scatter plots do not show non-linear relationships but attribute the non-homogeneity to either no relationship, the presence of households with zero use of large stores, or the tendency for certain variables to fall into categories. In area 1 (Moredun) Appendices F-1 and F-3 support the statement that a significant proportion of retired, or unemployed, people reside in this area. This, combined with the relative isolation of the area from the nearest large store, accounts for the non-homogeneity of the area.

7.4.6 This section of the analysis has computed the correlation matrices at area, means and total matrix level for input to the later statistical analyses. In addition the variable pairs have been examined, as has their homogeneity across all areas. This is important for two reasons, firstly to build a generalised model for all areas the relationship between dependent and independent variables must be homogeneous and secondly when considering the reasons why areal variation occurs these bivariate relationships will aid in the interpretation of the variation. The initial analysis of the worst areas of non-homogeneity has indicated that part of that non-homogeneity is due to zero usage of large stores and categorising of variables. These effects and the reason why no relationship exists in certain areas must be discussed once further analysis has been completed.

7.5 Identifying the Employment, Household Structure and Lifestyle Factors of Model 1 using Principal Components Analaysis

7.5.1 The second section of the analysis examines the postulate that the underlying data structure comprises two dependent factors and three independent factors. The two dependent factors are large store shopping, or bulk-purchasing of foodstuffs, and total household shopping and the three independent factors are employment, household structure and lifestyle. It is argued that these three influences, made up of a combination of household characteristics, determine both large store and total shopping usage.

7.5.2 The statistical technique selected in the previous chapter to determine this underlying data structure is principal components analysis. The analysis, which is carried out at area, area means and total matrix levels, does not use iteration because the without iteration method is a sufficiently good approximation for interpretation with a considerable saving in computer time. The rotation of the solution, using VARIMAX as discussed in the previous chapter, simplifies the structure and aids interpretation.[123]

7.5.3 Principal Components Analysis of the Total Data Matrix taking account of the effect of areal non-homogeneity on the data structure

The tests for non-homogeneity previously reported in this chapter identified area 1 (Moredun) and area 12 (Turnhouse) as the areas showing the greatest degree of non-homogeneity. Conversely area 3 (Clermiston), area 5

(Waverley), area 8 (Saughton), area 9 (Craigleith Hill), area 10 (Pilton) and area 13 (Leith) showed either no, or an insignificant proportion of, non-homogeneity. These seven areas were subjected to a principal components analysis to investigate their component data structure. The other areas were then added, in order of increased non-homogeneity presence, to see the effect these areas would have on the stability of the data structure. Table 21 lists the ordering of the area additions.

The principal components resulting from the six computer runs are shown in Tables 22 to 26. The first factor is of prime importance as are the extreme polar weightings of each factor. These tables show that the data structure remains stable as areas are added, so that the presence of non-homogeneity in certain areas, especially areas 1 and 12, does not impair the structure. This is important in the context of a generalised model based on component variables. The second order components do show change primarily because of the fifth component generated in the first two computer runs. However this stabilises as the areas are aggregated and affects only the minor components.

7.5.4 The Composition of the Total Data Matrix Components

In accord with the structure of Model 1 the principal components analysis on the total data structure separated the dependent and independent variables. The following principal components were output from the analysis :

PCA	Run 1	:	Areas 3, 5, 8, 9, 10, 13
PCA	Run 2	:	Areas 2 and 14 added
PCA	Run 3	:	Areas 11 and 16 added
PCA	Run 4	:	Areas 3 and 15 added
PCA	Run 7	:	Area 7 added
PCA	Run 6	:	Area 1 and 12 added

TABLE 21

Total Data Matrix Principle Component Analysis - Testing the Effect of Areal Non-Homogeneity on the Component Structure

Run 1 Areas: 3,5,8,9, 10,13	Run 2 Areas: 2,3,5,8,9, 10,13,14	Run 3 Areas: 2,3,5,6,8, 9,10,13, 14	Run 4 Areas: 2,3,4,5,6 8,9,10,11, 13,14,15	Run 5 Areas: 2,3,4,5,6 7,8,9,10, 11,13,14,	Run 6 All Areas: 1,2,3,4,5 6,7,8,9, 10,11,12, 13,14,15
Factor 1	Factor 1	Factor 1	Factor 1	Factor 1	Factor 1
Q 0.71016	Q 0.75152	Q 0.80799	Q 0.82217	Q 0.79658	Q 0.76408
K 0.67648	O 0.53059	M 0.71596	M 0.71445	M 0.66141	M 0.63038
O 0.51451	M 0.52133	O 0.69534	O o.68470	O 0.63669	O 0.59053
M 0.45823	K 0.48066	K 0.50530	K 0.52775	K 0.50597	K 0.53264
E 0.35814	E 0.37800	E 0.49094	E 0.48377	E 0.42941	E 0.40878
D 0.20663	D 0.18601	L 0.32621	L 0.33967	L 0.31046	L 0.30528
I 0.15328	I 0.16143	D 0.29483	D 0.28792	D 0.26456	D 0.25135
L 0.12242	L 0.14849	J 0.20159	J 0.22416	J 0.19769	J 0.20617
G -0.00921	H 0.09010	H 0.19341	H 0.18056	H 0.15468	I 0.06908
H -0.02234	J 0.03431	I 0.07020	G 0.07677	I 0.05623	G 0.04768
F -0.02456	C 0.00791	G 0.04817	I 0.05828	G 0.04730	F 0.02715
J -0.04578	G 0.00423	C 0.03008	C 0.03417	F 0.01989	H 0.14060
C -0.05190	F -0.03626	G 0.02608	F 0.01882	C -0.00357	C -0.01657
B -0.08419	B -0.07109	B -0.06492	B -0.08278	B -0.07522	B -0.06757
N -0.69750	P -0.71852	P -0.67654	R -0.65859	P -0.66705	R -0.65777
P -0.79251	N -0.72931	R -0.68088	P -0.66092	R -0.67181	P -0.68477
R -0.82530	R -0.83003	N -0.82209	N -0.79810	N -0.80079	N -0.78626

TABLE 22

Total Data Matrix Principle Components Analysis - Testing The Effect of Areal Non-Homogeneity

Run 1 Areas: 3,5,8,9, 10,13		Run 2 Areas: 2,3,5,8,9, 10,13,14		Run 3 Areas: 2,3,5,6,8, 9,10,13, 14		Run 4 Areas: 2,3,4,5,6 8,9,10,11, 13,14,15		Run 5 Areas: 2,3,4,5,6 7,8,9,10, 11,13,14,		Run 6 All Areas:	
Factor 2		Factor 2		Factor 2		Factor 2		Factor 2		Factor 2	
G	0.90686	F	0.94345	F	0.93088	F	0.92041	F	0.91840	F	0.92133
C	0.87985	B	0.90737	B	0.89507	B	0.89220	B	0.89568	B	0.89993
E	0.71981	D	0.87826	D	0.85216	D	0.86609	D	0.86609	D	0.87168
M	0.50766	E	0.34221	E	0.36092	E	0.37391	E	0.37566	E	0.38904
O	0.36905	K	0.14572	M	0.18045	M	0.14556	M	0.15955	M	0.15779
H	0.14955	I	0.12171	H	0.15880	H	0.12201	O	0.12843	K	0.12499
Q	0.13496	M	0.10968	R	0.14322	K.	0.11577	K	0.12486	O	0.10657
I	0.08050	H	0.10147	L	0.13331	R	0.10728	R	0.10847	L	0.09341
P	0.06258	O	0.09089	O	0.13278	L	0.10542	L	0.09509	R	0.09163
D	0.05154	L	0.09958	K	0.12716	O	0.10001	H	0.09389	I	0.09105
L	0.03183	R	0.06106	J	0.10936	J	0.08597	I	0.06549	H	0.07963
F	0.02449	C	0.02174	I	0.03966	I	0.05808	J	0.05704	J	0.05461
B	0.01927	J	0.00187	C	0.00898	C	0.00273	C	0.00235	C	0.01665
R	0.01503	P	-0.00339	P	-0.01409	P	-0.00575	P	-0.00578	Q	-0.04005
K	-0.06569	Q	-0.02927	Q	-0.01557	Q	-0.00580	Q	-0.02559	P	-0.04840
J	-0.08718	N	-0.11109	G	-0.12598	G	-0.12552	N	-0.14910	G	0.14728
N	-0.36122	G	-0.11857	N	-0.15617	N	-0.13175	G	0.15272	N	-0.15325

TABLE 23

Total Data Matrix Principle Components Analysis -

Testing the Effect of Areal Non-Homogeneity

Run 1 Areas: 3,5,8,9, 10,13		Run 2 Areas: 2,3,5,8,9, 10,13,14		Run 3 Areas: 2,3,5,6,8, 9,10,13, 14		Run 4 Areas: 2,3,4,5,6 8,9,10,11, 13,14,15		Run 5 Areas: 2,3,4,5,6 7,8,9,10, 11,13,14,		Run 6 All Areas:	
Factor 3		Factor 3		Factor 3		Factor 3		Factor 3		Factor 3	
F	0.95345	L	0.80545	J	0.76338	J	0.72525	J	0.72588	J	0.70530
B	0.91361	J	0.71809	L	0.69207	L	0.69207	L	0.69118	L	0.68533
D	0.88227	K	0.56519	K	0.66803	K	0.65363	K	0.67273	K	0.62593
E	0.28958	M	0.55083	I	0.56235	I	0.59964	I	0.60778	I	0.58362
M	0.13202	O	0.54422	R	0.28330	R	0.30684	R	0.30476	R	0.33277
O	0.10704	Q	0.37938	D	0.23375	O	0.21023	O	0.24642	O	0.24911
K	0.09758	R	0.29054	Q	0.22978	D	0.18368	Q	0.23135	D	0.20833
H	0.09357	E	0.27979	O	0.22585	Q	0.18128	D	0.20675	M	0.20375
R	0.08369	D	0.25501	E	0.21462	M	0.16979	M	0.19869	Q	0.20500
I	0.07900	I	0.09793	M	0.17768	E	0.14695	E	0.18436	E	0.17140
L	0.07127	F	0.04875	F	0.04539	F	0.04055	F	0.02396	F	0.03796
C	0.00189	G	0.02129	G	0.00073	N	-0.03757	N	-0.01325	N	-0.02572
J	-0.01954	B	-0.07665	N	-0.04057	G	-0.03775	G	-0.03877	B	-0.04985
Q	-0.02075	C	-0.08292	B	-0.08170	B	-0.06162	B	-0.06117	G	-0.04464
P	-0.02470	H	-0.10099	C	-0.12530	C	-0.10553	C	-0.11368	C	-0.11224
G	-0.09351	P	-0.19908	P	-0.31743	P	-0.33722	P	-0.33630	P	-0.32889
N	-0.12496	N	-0.33800	H	-0.55442	H	-0.58093	H	-0.56670	H	-0.57811

TABLE 24

Total Data Matrix Principle Components Analysis -

Testing the Effect of Areal Non-Homogeneity

Run 1 Areas: 3,5,8,9, 10,13		Run 2 Areas: 2,3,5,8,9, 10,13,14		Run 3 Areas: 2,3,5,6,8, 9,10,13, 14		Run 4 Areas: 2,3,4,5,6 8,9,10,11, 13,14,15		Run 5 Areas: 2,3,4,5,6 7,8,9,10, 11,13,14,		Run 6 All Areas:	
Factor 4		Factor 4		Factor 4		Factor 4		Factor 4		Factor 4	
J	0.79076	G	0.91917	G	0.91257	G	0.90588	G	0.89459	G	0.88693
L	0.78963	C	0.90110	C	0.88873	C	0.88692	C	0.87870	C	0.87701
K	0.60144	E	0.63607	E	0.56588	E	0.56798	E	0.60991	E	0.61498
Q	0.49787	M	0.36825	M	0.35663	M	0.36761	M	0.42149	M	0.45883
M	0.48002	O	0.24341	O	0.22463	O	0.25679	O	0.29087	O	0.33117
O	0.44145	H	0.13003	R	0.13192	R	0.16095	R	0.15655	R	0.16957
D	0.23501	I	0.10345	P	0.12827	P	0.07199	P	0.09307	P	0.07672
I	0.21296	P	0.07348	H	0.11816	L	0.04733	H	0.06786	Q	0.07467
R	0.20500	Q	0.06530	L	0.08332	I	0.02404	L	0.06478	L	0.07091
E	0.19607	R	0.02805	I	0.05193	H	0.02249	Q	0.06289	H	0.06657
H	0.03441	L	0.01712	Q	0.03581	B	0.01941	I	0.04492	I	0.03917
F	0.02173	B	0.01658	B	0.01098	Q	0.00614	B	0.01738	B	0.03142
G	-0.04259	F	0.00927	F	-0.00778	F	-0.01335	D	-0.01032	D	-0.00711
B	-0.08456	D	0.00574	D	-0.03461	D	-0.03686	K	-0.02072	K	-0.00837
P	-0.09180	K	-0.03586	J	-0.03813	K	-0.05494	F	-0.02569	F	-0.01016
C	-0.11452	J	-0.08652	K	-0.05282	J	-0.09497	J	-0.05152	J	-0.04564
N	-0.26208	N	-0.23148	N	-0.13301	N	-0.16271	N	-0.11618	N	-0.13656

TABLE 25

Total Matrix Principle Components Analysis -

Testing the Effect of Areal Non-Homogeneity

Run 1 Areas: 3,5,8,9, 10,13		Run 2 Areas: 2,3,5,8,9, 10,13,14		Run 3 Areas: 2,3,5,6,8, 9,10,13, 14
Factor 5		Factor 5		Factor 5
H	0.83627	I	0.71503	
P	0.16926	K	0.41437	
N	0.15413	J	0.32529	
E	0.13829	L	0.10290	
Q	0.13071	D	0.08345	
M	0.04252	N	0.07395	
G	0.02828	E	0.04348	
L	0.02256	F	0.00273	
R	0.01614	G	0.00036	
B	0.01072	Q	-0.00076	
F	0.00224	R	-0.02069	
D	-0.00527	B	-0.05039	
G	-0.01111	C	-0.07039	
O	-0.08399	O	-0.15701	
K	-0.11461	M	-0.21732	
J	-0.23358	P	-0.30061	
I	-0.52075	H	-0.63627	

TABLE 26

Total Data Matrix Principle Components Analysis -

Testing the Effect of Areal Non-Homogeneity

Dependent Variables (79.6% variance explained)

Factor 1 (45.7%)		Factor 2 (33.9%)	
Variable	Weighting	Variable	Weighting
Exp.at store (D)	0.93	Total shopping freq. (G)	0.91
Freq.at store (F)	0.91	Total shopping hours (C)	0.89
Hours at store (B)	0.86	Total shopping expend. (E)	0.68

Independent Variables (63.6% variance explained)

Factor 1 (38.2%)		Factor 2 (15.2%)		Factor 3 (10.2%)	
Variable	Weighting	Variable	Weighting	Variable	Weighting
Household Size (M)	0.89	No. of Cars (J)	0.73	Personal Access(R)	0.87
S.D. of Ages(O)	0.86	Income (K)	0.69	SEG (P)	0.59
Mean Age (N)	-0.74	No. of Lics.(L)	0.65	Employment (Q)	-0.63
		Freezer Ownership(I)	0.62		

The data structure shows the dependent variables clearly split into a large store component and a total shopping component and the independent variables split into three components which correspond to the household factor, the lifestyle and the employment factor of Model 1. The dependent components explain 79.6% of the dependent variable variance and the independent components explain 63.6% of the independent variable variance. The household factor is the dominant component explaining 38.2% of the variance. The three variables comprising this factor have weightings showing their importance. In the third factor note that as employment rises the personal accessibility of the principal shopper falls reflecting the increasing number of working wives in the population.

The bulk-buying expenditure variable is of prime importance in the first dependent variable component but the total shopping expenditure variable is of third order importance in the second component. This indicates that once the household decides to spend a certain budget at a large store the frequency of smaller shopping trips becomes more important rather than the amount of budget residue left in the household shopping account. This minor shopping trip budget shows less variation than frequency and duration of these trips.

7.5.5 The Principal Components Analysis of each Individual Area

The analysis described in the previous section indicated a meaningful overall data structure that corresponds with Model 1 of the conceptual framework. This structure was not affected by the non-homogeneity present in some areas. This section carries out a principal components analysis on each area to investigate if the total data structure occurs at individual area level thus indicating that a generalised model, based on Model 1, can be achieved.

Tables 27 and 28 list the component structure by area of the dependent and independent variables respectively. The percentage of variance explained by each component after rotation is listed underneath each component. The percentage of variance explained varies from eighty-five percent to one hundred percent.

The dependent variable structure in all areas, except area 11 (Cammo), conforms to the general structure. This is not the case with the independent data structures. The primary factor in the majority of areas is household

Area No.	Factor 1 Variable	Weighting	Factor 2 Variable	Weighting	Factor 3 Variable	Weighting
1	F	0.98	C	0.99		
	B	0.92	G	0.81		
	D	0.89	E	0.40		
	(60.8%)		(39.2%)			
2	B	0.99	C	0.96	D	0.70
	F	0.87	G	0.79	E	0.70
	D	0.49				
	(54.2%)		(28.5%)		(17.3%)	
3	F	0.96	G	0.97		
	B	0.86	E	0.78		
	D	0.75	C	0.64		
	(70.4%)		(29.6%)			
4	D	0.98	G	0.85		
	F	0.85	C	0.83		
	B	0.84	E	0.59		
	(60.7%)		(39.3%)			
5	G	0.96	D	0.90		
	C	0.93	F	0.83		
	E	0.86	B	0.76		
	(62.2%)		(37.8%)			

TABLE 27a

Principle Components Analysis - Factor Composition for Each Area

(Dependent Factors)

Area No.	Factor 1 Variable	Factor 1 Weighting	Factor 2 Variable	Factor 2 Weighting	Factor 3 Variable	Factor 3 Weighting
6	D	0.88	C	0.98		
	B	0.85	G	0.91		
	F	0.83	D	-0.36		
	E	0.78				
	(59.4%)		(40.6%)			
7	B	0.96	E	0.83		
	D	0.88	G	0.80		
	F	0.81	C	0.55		
	(62.1%)		(37.9%)			
8	F	0.95	G	0.95		
	D	0.93	C	0.92		
	B	0.89	E	0.65		
	(56.8%)		(43.2%)			
9	D	0.96	G	0.89		
	F	0.85	C	0.81		
	B	0.82				
	(66.0%)		(34.0%)			
10	F	0.99	G	0.99		
	B	0.90	C	0.71		
	D	0.89	E	0.61		
	(60.7%)		(39.3%)			

TABLE 27b

Principle Components Analysis - Factor Composition for Each Area

(Dependent Factors)

Area No.	Factor 1		Factor 2		Factor 3	
	Variable	Weighting	Variable	Weighting	Variable	Weighting
11	E	0.98	B	0.73	C	0.62
	D	0.95	G	-0.74	B	0.42
	F	0.50				
	(56.8%)		(27.1%)		(16.0%)	
12	D	0.99	C	0.89		
	F	0.84	G	0.84		
	B	0.75	E	0.58		
	E	0.70				
	(69.8%)		(30.2%)			
13	G	0.96	F	0.98		
	E	0.87	D	0.83		
	C	0.82	B	0.70		
	(69.5%)		(30.5%)			
14	D	0.96	G	0.92		
	F	0.89	C	0.88		
	B	0.87	E	0.52		
	(62.8%)		(37.2%)			
15	G	0.97	D	0.97		
	C	0.79	F	0.68		
	E	0.76	B	0.66		
	(53.4%)		(46.6%)			

TABLE 27c

Principle Components Analysis - Factor Composition for Each Area

(Dependent Factors)

Area No.	Factor 1 Variable	Weighting	Factor 2 Variable	Weighting	Factor 3 Variable	Weighting	Factor 4 Variable	Weighting
1	R	0.92	M	0.94	J	0.85	L	0.79
	P	0.87	O	0.94	K	0.58	Q	-0.76
	N	0.64	N	-0.60	I	0.42		
	K	-0.70	N	-0.60	Q	0.40		
					L	0.38		
	(35.8%)		(17.3%)		(13.9%)		(11.5%)	
2	Q	0.87	M	0.63	J	0.61	I	0.48
	K	0.78	O	0.63	R	0.56	L	0.47
	L	0.74	P	0.54	N	0.40	J	-0.64
	M	0.70	R	0.48	I	0.38		
	O	0.67	I	0.62	K	0.35		
	(43.8%)		(18.8%)		(12.2%)		(10.0%)	
3	M	0.90	K	0.87				
	O	0.87	Q	0.54				
	Q	0.71	P	-0.76				
	L	0.51	R	-0.83				
	I	-0.52						
	N	-0.68						
	(44.4%)		(22.2%)					
4	K	0.80	M	0.87	Q	0.76		
	L	0.80	O	0.84	K	0.43		
	I	0.78	N	-0.89	R	-0.89		
	J	0.70						
	P	-0.74						
	(39.3%)		(20.5%)		(15.0%)			
5	Q	0.84	J	0.92				
	O	0.84	L	0.88				
	M	0.80	K	0.84				
	I	0.64	P	-0.52				
	P	-0.69						
	R	-0.79						
	N	-0.92						
	(58.0%)		(19.8%)					

TABLE 28a

Principle Components Analysis - Factor Composition for Each Area

(Independent Factors)

Area No.	Factor 1 Variable	Factor 1 Weighting	Factor 2 Variable	Factor 2 Weighting	Factor 3 Variable	Factor 3 Weighting	Factor 4 Variable	Factor 4 Weighting
6	M	0.73	I	0.83	R	0.80		
	Q	0.72	J	0.77	L	0.65		
	O	0.63	Q	0.53	K	-0.73		
	P	-0.84	L	0.51				
	N	-0.91						
	(37.8%)		(19.6%)		(13.4%)			
7	Q	0.83	M	0.88	N	0.79		
	J	0.78	O	0.78	R	0.78		
	K	0.71	N	-0.29	P	0.42		
	I	0.62	P	-0.39	Q	-0.21		
	L	0.48						
	P	-0.36						
	(38.7%)		(15.7%)		(12.8%)			
8	Q	0.84	L	0.81	I	0.81		
	M	0.81	J	0.76	J	0.46		
	O	0.78	K	0.51	R	0.31		
	K	0.78	Q	0.38				
	R	-0.69	P	-0.12				
	P	-0.75						
	N	-0.89						
	(50.4%)		(12.7%)		(11.7%)			
9	K	0.81	I	0.89	L	0.82		
	Q	0.68	M	0.75	J	0.82		
	O	0.65	Q	0.49	R	0.65		
	N	-0.78	O	0.48				
	P	-0.95	N	0.43				
	(51.9%)		(18.3%)		(10.2%)			
10	O	0.90	K	0.89	R	0.83		
	M	0.86	Q	0.85	P	0.75		
	L	0.47	J	0.72	L	0.44		
	N	-0.85	I	0.54	J	0.37		
					Q	-0.29		
	(37.9%)		(18.6%)		(14.7%)			

TABLE 28b

Principle Components Analysis - Factor Composition for Each Area

(Independent Factors)

Area No.	Factor 1 Variable	Factor 1 Weighting	Factor 2 Variable	Factor 2 Weighting	Factor 3 Variable	Factor 3 Weighting	Factor 4 Variable	Factor 4 Weighting
11	Q	0.91	O	0.77				
	J	0.86	M	0.76				
	L	0.85	I	0.74				
	K	0.79	P	-0.71				
	R	-0.59	N	-0.93				
	(58.1%)		(14.4%)					
12	M	0.87	J	0.80	Q	0.83	I	0.72
	O	0.83	L	0.66	K	0.79	N	0.61
	N	-0.46	P	-0.74			R	-0.67
	(28.1%)		(17.1%)		(12.9%)		(12.1%)	
13	O	0.84	J	0.91	R	0.93	L	0.96
	M	0.81	I	0.77	P	0.67	Q	0.56
	N	-0.85	K	0.74	K	-0.63		
			P	-0.36	Q	-0.63		
	(41.4%)		(17.1%)		(12.5%)		(10.0%)	
14	M	0.91	Q	0.67				
	O	0.87	I	0.65				
	L	0.70	K	0.50				
	K	0.68	J	0.49				
	P	-0.73	P	-0.41				
	N	-0.94	R	-0.76				
	(56.2%)		(12.6%)					
15	M	0.92	J	0.82	I	0.93	L	0.97
	O	0.86	Q	0.79	N	0.45	N	-0.39
	K	0.83	R	0.73	P	0.41		
	N	-0.73						
	P	-0.73						
	(43.3%)		(15.4%)		(12.6%)		(11.1%)	

TABLE 28c

Principle Components Analysis - Factor Composition for Each Area

(Independent Factors)

structure but it contains other prominent variables pertinent to the area. The other two general factors can be identified in some areas but were intermingled with other variables. The number of components varied from two to four.

This result corresponds to the initial areal investigation based on the profile of means and standard deviations by area and the local disaggregation that could be achieved. It may be possible to use the stable total data matrix structure on an aggregated basis or if the same structure is confirmed by examination of the means data matrix. Conversely the second model using individual areas may be able to respond to this areal variation. The initial criticism of Model 1 still pertains in that the measurement of the five factors would pose severe practical problems.

7.5.6 Area Means Matrix Principal Components Analysis, Without a Spatial Accessibility Index

The area means matrix is listed in Table 9. These average values for each variable over all areas smooth the household variation within areas and provide an area measure commensurate with zoning in transportation modelling. The principal components analysis was carried out with the dependent and independent variables separated, as with the total matrix. The component structure is as follows :

Dependent Variables (100% variance explained)

Factor 1 (61.2%)		Factor 2 (38.8%)	
Variable	Weighting	Variable	Weighting
Exp.at store (D)	0.93	Total shopping freq. (G)	0.99
Freq.at store (F)	0.93	Total shopping hours (C)	0.69
Hours at store (B	0.72	Total shopping expend. (E)	0.27

Independent Variables (84.8% variance explained)

Factor 1 (47.1%)		Factor 2 (24.7%)		Factor 3 (13.0%)	
Variable	Weighting	Variable	Weighting	Variable	Weighting
Freezer Ownership(I)	0.92	Mean Age (N)	0.83	No. in Household(M)	0.92
Income (K)	0.90	SEG (P)	0.77	SD of ages(O)	0.87
No. of Lics.(L)	0.89	Employment (Q)	-0.61	Mean Age (N)	-0.28
Personal Access (R)	0.85				

The dependent variable structure corresponds with the total data matrix structure showing the two shopping components explaining all the variance in the variable means. The independent structure also corresponds with the total data matrix structure except for the presence of personal accessibility in the lifestyle component, mean age in the employment component and the relegation of the household structure component to the third order. Note that the variable J is omitted due to collinearity problems and this has affected the composition of the first component.

7.5.7 Area Means Matrix Principal Components Analysis, with a Spatial Accessibility Index

The combining of area means in one matrix means that competition is no longer constant within the matrix. The spatial accessibility of each area differs according to the opportunities to bulk-buy with respect to that area. However the data structure shown in the preceding section indicated that the effect of competition did not radically affect the stability of the data structure. In chapter 4 accessibility was argued as comprising three elements :

a) the personal accessibility of the principal shopper
b) the spatial accessibility of the store
c) the relative attraction of the store.

The first term has been included in the analysis, the second and third terms have not. It was proposed to use the basic form of the accessibility model :

$$S_i = \sum_{j=1}^{n} \frac{A_j}{d_{ij}} \lambda$$

where S_i = spatial accessibility to stores 1 to n from households in area i

A_j = attractiveness of store j

d_{ij} = straight-line distance from i to j

λ = calibration factor.

In keeping with the concept of integrating the disaggregate trip generation model with a standard gravity-type distribution model it is proposed to use retail sales area as the measure of attractiveness and straight-line distance as the measure of deterrence. These are also in keeping with the strategic role of the model in development control. If it is assumed that the maximum driving contour is twenty-five minutes all sixteen large shopping stores in the study area are included. These stores, as identified by the Physical Planning Department, Lothian Regional Council are listed in Table 29. The locations of the stores with respect to the fifteen study sub-areas are shown in Figure 23.

The spatial accessibility indices were computed using a power factor of two for lambda. This has been proved by empirical studies to be the power function best suited to shopping models.(124) These values are listed in Table 30. However values for lambda of one and three will also be computed and compared.

The principal components analysis of the means data matrix with spatial accessibility index was carried out with the dependent and independent variables separated. The resultant data structure is as follows :

Dependent Variables (100% variance explained)

Factor 1 (47.4%)		Factor 2 (31.3%)	
Variable	Weighting	Variable	Weighting
Exp.at store (D)	0.93	Total duration of shopping(C)	0.99
Freq.at store (F)	0.93	Total freq. of shopping(G)	0.69
Duration at store(B)	0.73	Total expend. of shopping(E)	0.27

Independent Variables (79.5% variance explained)

Factor 1 (44.4%)		Factor 2 (23.1%)		Factor 3 (12.0%)	
Variable	Weighting	Variable	Weighting	Variable	Weighting
Freezer Ownership(I)	0.92	No. in Household(M)	0.92	Mean Age (N)	0.81
Income (K)	0.89	SD of ages(O)	0.84	SEG(P)	0.77
No. of Lics.(L)	0.88	Spatial Access(S)	0.60	Employment (Q)	-0.61
Personal Access (R)	0.85	Mean Age (N)	-0.32		

The addition of spatial accessibility has the effect of raising the household structure factor to the second order thereby bringing the means data structure closer to the total data structure. The household structure factor is now a composite measure which includes spatial accessibility. Table 31 shows the variables with which the spatial acessibility index is correlated. Note that the three large store variables, in addition to total shopping expenditure, are correlated. Spatial accessibility is intercorrelated with the independent variables of income and household size. This indicates that the spread of bulk-buying opportunities influences the use of large stores and indeed the total shopping budget. This is supported by the bivariate relationship with income. The positive relationship with household size is a measure of the marketing potential of the stores in that as household size rises the opportunity to bulk-buy rises. It is to be noted that none of these bivariate relationships is particularly strong and the overall effect on the component structure is to reduce the percentage of the variance explained from 100% to 78.7% for the dependent structure and from 84.8% to 79.5% for the independent structure.

	Approximate Floorspace Gross Ft^2	Gross M^2	Sales Ft^2	Sales M^2	Data Source	Located in Area
Local Centres						
Safeway, East Craigs	20,000	1,860	16,000	1,490	1	1
Safeway, East Craigs	26,000	2,420	20,000	1,860	2	1
Safeway, East Craigs	-	-	19,000	1,770	6	1
Safeway, Jock's Lodge	14,250	1,350	-	-	2	4
Safeway, Jock's Lodge	15,600	1,450	-	-	10	4
Safeway, Jock's Lodge	-	-	10,000	930	6	4
Safeway, Davidson's Mains	14,250	1,320	10,330	960	2	2
Safeway, Davidson's Mains	15,800	1,470	-	-	10	2
Safeway, Davidson's Mains	-	-	10,100	940	6	2
Stores Outwith Existing Centres						
Asda, Milton Road	71,260	6,630	39,000	3,630	2	6
Asda, Milton Road	-	-	42,300	3,930	6	6
Asda, Milton Road	69,370	6,450	46,930	4,360	8	6
Asda, Milton Road	73,000	6,800	42,000	3,900	9	6
Trendcentre, Granton	43,500	4,050	30,000	2,790	2	3
Trendcentre, Granton	-	-	40,000	2,720	6	3
Trendcentre, Granton	40,000	3,700	30,000	2,800	9	3
Trendcentre, Chesser Ave.	45,000	4,190	18,500*	1,720*	2	14
Trendcentre, Chesser Ave.	41,000	3,180	22,000*	2,050	1	14
Trendcentre, Chesser Ave.	-	-	23,300*	2,070*	6	14
Tesco, Drumdryden Drive	29,000	2,700	18,000	1,670	4	15

* Food Only

TABLE 29

Large Foodstores in Edinburgh District

	Approximate Floorspace Gross Ft²	M²	Sales Ft²	M²	Data Source	Located in Area
City Centres						
Templeton, St James Centre	13,000	1,210	9,800	910	1	8
Templeton, St James Centre	15,690	1,460	9,010	840	2	8
Marks & Spencers, Princes St.	-	-	12,040*	1,120*	3	9
British Home Stores, Princes St.	-	-	8,640*	800*	3	10
Littlewoods, Princes St.	-	-	7,120*	600*	3	11
Inner Suburbs						
Laws, Nicolson Street	9,800	910	9,400	870	1	7
Fine Fare, Dalry Road	-	-	11,000	1,020	1	12
Fine Fare, Dalry Road	18,620	1,730	11,540	1,070	2	12
Fine Fare, Dalry Road	-	-	11,460	1,070	6	12
Fine Fare, Dalry Road	14,400	1,340	11,500	1,070	5	12
District Centres						
Scotmid, Portobello	-	-	-	-	-	5
Presto, Wester Hailes	59,000	5,490	39,000	3,630	2	16
Preston, Wester Hailes	59,000	5,500	39,000	3,600	2	16
Safeway, Morningside	26,110	2,430	18,690	1,740	7	13
Safeway, Morningside	-	-	20,770	1,930	6	13

TABLE 29 (Contd.)

Large Foodstores in Edinburgh District

MAJOR CONVENIENCE STORES IN LOTHIAN

Data Sources :

1. Store Managers (January/February 1982)
2. Edinburgh District Floorspace Survey (1976)
3. Personal Inspection (June 1982)
4. Personal Inspection (September 1982)
5. Personal Inspection (October 1982)
6. IGD Large Stores Directory (1982) or Superstore Directory (1982)
7. Planning Application (January 1979)
8. Measurement of plans for reorganisation of Store (May 1982)
9. URPI List of Hypermarkets and Superstores (1982)
10. Montagu Evans & Son 'Shopping Survey Report' (September 1978)
11. New Towns Annual Report 1981.

TABLE 29 (Contd.)

Large Foodstores in Edinburgh District

FIGURE 23

Location of Large Foodstores in Edinburgh District

Area No.	S_j	Area No.	S_j
1	0.4	8	1.8
2	2.0	9	1.1
3	1.5	10	1.3
4	0.5	11	1.6
5	1.6	12	0.8
6	19.6	14	1.2
7	3.2	15	1.2

NOTES:

1) Area 6 is adjacent to a superstore.
2) $\lambda = 2$. Other values of lambda are compared with this value later in the analysis.

TABLE 30

Spatial Accessibility Indices for Individual Areas

Variable Pair	Pearson Correlation Coefficient	Significance Level (x 100%)
S - B (Duration at Store)	0.52	0.02
S - D (Expenditure at Store)	0.44	0.05
S - E (Tot.Shopping Expenditure)	0.51	0.02
S - F (Frequency at Store)	0.55	0.01
S - K (Income)	0.46	0.04
S - M (Household Size)	0.51	0.03

TABLE 31

Pearson Correlation Coefficients for Spatial Accessibility and Variables Exhibiting a Significant Relationship

If the variables are not separated and a principal components analysis is carried out, the addition of spatial accessibility creates a fifth order component of spatial accessibility, expenditure at store and total duration and total expenditure of shopping. This component explains 7.5% of the variance in the variables. As is expected spatial accessibility to bulk-buying opportunities does relate to usage of these large stores but is of minor importance in explaining the measurement of trip rate.

7.5.8 Comments on the Principal Components Analysis

The purpose of the principal components analysis was to confirm the factor structure of Model 1 and thereby define a usage factor which could be predicted by independent factors based on household characteristics, i.e. the analysis indicates what factors are being measured by the dependent and independent variables. The analysis did confirm the postulated structure of Model 1 at total data matrix and means data matrix level and the non-homogeneity of variable pairs in some areas did not affect the stability of the structure.

However the analysis of the individual areas showed that although the dependent structure held true the independent structure was unstable. The general factors were evident in over half the areas but were influenced by dominant local factors such as proximity of a large store and high proportion of retired persons. This can have the effect of increasing, or reducing, the bulk-buying capacity of an area in a way that would not be expected from the level of income in the area. This means that the effects of such external influences as proximity of a large store and internal influences such as a large proportion of retired households affect the stability of the general model. This consequently throws doubt on the ability to generalise a structure over all areas at the househild level. Both the individual areal profiles and areal data structures indicate that the shopping usage variables can be represented by a bulk-buying term and a total shopping term. However this usage level is arrived at in different ways depending on the variable strengths in that area. Each area has its own dominant characteristics that influence the shopping usage patterns of the area. The end result may be the same level of superstore usage but the influencing variable combinations may be different.

Thus this implies that a model based on the three factors of model 1 would be limited in that the general factor structure of Model 1 cannot cope with the within areal variations. As these variations are subdued through aggregation, Model 1 can represent the generalised structure. This is seen in the structure of the total data matrix and the means matrix. Therefore a trip prediction model based on Model 1 would apply at the aggregated level and not at individual area level. This should be evident from the multiple regression analysis.

7.6 Examination of the Strength and Structure of the Relationship between the Dependent and Independent Variables using Canonical Correlation Analysis

7.6.1 Before developing the trip prediction capabilities of the postulated models it is necessary to examine the strength and structure of the relationship between the dependent and independent variables to see if there is a basis for model development. As has been discussed in chapter 6 canonical correlation analysis is a generalisation of multiple regression analysis which enables the maximum relationship to be determined between a dependent and independent set of variables. The canonical correlation coefficient indicates the extent of the correlation between the two variable sets when the variables are weighted so as to yield their maximum correlation. As with principal components analysis the canonical variates are independent and uncorrelated.

7.6.2 Canonical Correlation Analysis for Individual Areas

A canonical correlation analysis was carried out for each area using all the dependent and independent variables excepting House Type (H) and Number of Household Cars (J) both of which were causing multi-collinearity problems. Table 32 lists details of the analysis. The first order canonical variates significant at the 5% level are shown, except in areas 1, 4, 5, 12 and 13 where no significant variate was found and the first order variate is listed. The eigenvalues can be multiplied by one hundred to obtain the percentage of the variance explained in the two variable sets. The addition of Number of Household Cars (J) to area 13 brought the canonical coefficient up to 0.92 and the significance level to 0.03. The variable J did not produce multi-collinearity in area 13. The addition of J to areas 1, 4, 5 and 12 did not alter the level of significance.

7.6.3 These individual area results show that a strong relationship exists between the dependent and independent variables. The total data matrix however, shows only 41% of the variance explained and supports the conclusion, indicated by the principal components analysis, that the household characteristics of an area can predit usage of large stores but do so in different ways depending on the dominant characteristics of the area.

7.6.4 The Structure of the First Order Canonical Variates

The variables, weighted over 0.5, comprising the first order variates are shown in Table 33. There is no consistent structure to either the dependent or

Area No.	Eigenvalue	Canonical Correlation Coefficient	With S Lambda	Chi-Square	D.F.	Significance Level
1	0.88	0.94	0.01	59.38	54	0.29
2	0.98	0.99	0.00	73.78	54	0.04
3	0.93	0.96	0.00	76.24	54	0.03
4	0.81	0.90	0.03	58.26	54	0.32
5	0.77	0.88	0.04	52.80	54	0.52
6	0.94	0.97	0.00	78.98	54	0.02
7	0.82	0.91	0.01	80.26	54	0.01
8	0.84	0.92	0.01	88.78	54	0.00
9	0.92	0.96	0.01	81.13	54	0.01
10	0.87	0.94	0.01	81.42	54	0.01
11	1.00	1.00	0.00	89.80	54	0.00
12	0.88	0.94	0.02	70.69	54	0.06
13	0.74	0.86	0.02	71.42	54	0.06
14	0.87	0.93	0.01	72.08	54	0.05
15	0.87	0.93	0.02	73.44	54	0.04
16 (total)	0.41	0.64	0.47	271.84	54	0.00

TABLE 32

Canonical Correlation Analysis Between Variables B, C, D, E, F and G and I, K, L, M, N, O, P, Q and R for Each Individual Area

Area No.	Usage Index Structure of Canonical Variate	Independent Variable Structure of Canonical Variate
1	1.8F - 0.6E - 1.9B	0.6R - 1.2M
2	1.2D + 1.0B - 0.8C - 1.6F	0.9M + 0.5P - 0.6J - 0.8O
3	1 - 11E	0.9M + 0.7R - 0.6P
4	1.6D + 1.3G - 0.7E - 1.3F	1.4M + 0.7N - 0.5O
5	1.5G + 1.3D - 0.8C	1.0Q + 0.5P + 0.5R - 0.7O - 0.8N
6	1.5E + 1.0C - 2.4G - 2.7D	-0.8M - 0.6N - 0.5J (+0.2I)
7	1.3E - 0.6G	0.7K - 0.5Q - 0.7N
8	1.6D + 0.9C - 0.9B - 1.8E	-1.0M + 0.7O
9	1.9D - 1.1B	0.7Q + 0.5I (-0.4P)
10	0.6G + 0.5D - 0.9C	0.8M + 0.7Q + 0.6N - 0.7L
11	0.6D + 0.6F - 0.8B	1.0Q + 0.6J + 0.5K - 0.7P - 1.3L
12	0.5C - 1.2B	0.7O + 0.6K + 0.5N + 0.5P (-0.1L)
13	0.6D - 1.0G - 1.4F	0.9J + 0.5L - 0.8O - 0.8P - 1.2K
14	1.1B - 1.1D	0.6M + 0.5N - 0.5K - 0.8P - 0.9L
15	-0.9E (+0.4D)	0.9Q + 0.7N - 0.7O
16	0.8E + 0.5D (-0.3B)	0.6M (-0.04N)

TABLE 33

Structure of First Order Canonical Variates for Individual Areas independent variable sets over the fifteen areas. Groups of similar areas can be identified, such as areas 2, 4 and 13 whose poles are expenditure at the store (D) and frequency at the store (F), but the independent structure is not the same for these areas. Household structure figures prominently on the independent side of the equation as does shopping expenditure on the dependent side. This is in line with the strength of the bivariate relationships previously examined. The total data matrix shows three significant canonical variates which explain 41%, 10% and 6% respectively of the variance in the variable sets. The structure of these variates does not relate to the individual area structures.

The analysis indicates that a general model to household level will not be possible due to the variation within each area. There is however a relationship between household characteristics and store usage which can be further explored. Also the possibility of combining areas will be explored, as discussed in the previous chapter, using cluster analysis.

7.6.5 Canonical Correlation Analysis using the Means Data Matrix, with and without the Spatial Accessibility Index

The canonical correlation analysis for the means data matrix, with and without the spatial accessibility index, is shown in Table 34. It was expected, based on the results of the principal components analysis, that a strong canonical correlation would exist between the two sets of variables and this is shown to be true. The effect of adding spatial accessibility is the appearance of a third significant canonical variate.

The structure of the variates is shown in Table 35. The two dependent variates are based on shopping expenditure

Eigenvalue	Canonical Correlation Coefficient	With S Lambda	Chi-Square	D.F.	Significance Level
<u>Without S</u> :					
1.00	1.00	0.0	9999.0	60	0.00
1.00	1.00	0.0	9999.0	45	0.00
(0.96	0.98	0.0	32.17	32	0.46)
<u>With S</u> :					
1.00	1.00	0.0	9999.0	66	0.00
1.00	1.00	0.0	9999.0	50	0.00
1.00	1.00	0.0	9999.0	36	0.00
(0.96	0.98	0.06	25.18	24	0.40)

TABLE 34

Canonical Correlation Analysis for Means Data Matrix with and without the Variable S

Variate	Dependent Variables	Independent Variables
Without S :		
1	0.8D + 0.7B - 0.6E	1.1R + 0.9K + 0.70 - 1.4P - 2.5L
2	1.4G _ 1.0B - 0.6D - 1.4C	1.9J + 1.8I + 1.2R - 1.1N - 1.2P - 5.4L
With S :		
1	1.0B (-0.3E)	1.3R + 0.9K + 0.60 - 1.3P - 2.5L
2	1.3C - 0.8B - 1.4G	5.4L + 1.2P + 1.1N - 1.1R - 1.9I - 2.0J
3	1.6E + 1.4B - 1.3C - 2.6D	1.3L + 0.9R + 0.5Q + 0.5P - 0.60 - 0.9S - 0.9I - 1.1J

TABLE 35

The Structure of the Canonical Correlation Variates with respect to the Means Data Matrix, with and without S and total shopping usage and the independent variates are based on the number of licenses (L), the number of cars (J) and the personal accessibility of the principal shopper (R). The addition of spatial accessibility adds a third variate based on duration of stay at the store (B) and expenditure at the store (E). These structures reinforce the previous analysis at total data matrix and individual area level that a common usage factor cannot be identified over all the areas at household level.

7.6.6 The Value of the Power Function, Lambda, in the Spatial Accessibility Index

As previously mentioned in the chapter the value of two was assumed for lambda[124], however values of one and three were examined to investigate their effect. Appendix G shows the results of the investigation. Appendix G-1 shows the principal components analysis for the three values of lambda. Only the value of two generates the fifth spatial accessibility component and the structure is stable for values of two and three. Appendix G-2 shows the canonical correlation coefficients for the three values of lambda. The value of two shows a third significant variate with a canonical coefficient of one. Appendix G-3 lists the variate structures and shows that a value of three for lambda causes instability. On the basis of these results and the previous work referred to earlier it is proposed that the value of two for the power function lambda is accepted.

7.6.7 The Reduction in Strength of the Overall Canonical Correlation with Aggregation

It has been shown that as areas are aggregated the principal components structure tends to the general structure. However as areas are aggregated the effect of areal variation reduces the strength of the relationship between the dependent and independent variables. Thus although the canonical correlation for each area is strong the overall canonical correlation for the total data matrix is 0.64. Table 36 shows the area groupings used to test if the non-homogeneity within areas affected the component data structure. These groupings were subjected to a canonical correlation analysis and the diluting effect of gradual aggregation can be clearly seen. No one area is responsible for the dilution of relationship indeed the addition of areas 1 (Moredun) and 12 (Turnhouse), areas which showed the greatest degree of non-homogeneity, decrease the overall canonical correlation by only 0.02%. This gradual dilution of relationship is expected since the proportional increase in the size of the aggregated group at each stage of the analysis does not exceed 10%. Thus the interpretation of each area describing usage in different ways is supported. The areal variations work against each other to dilute the strong areal relationships. The means data matrix smooths out the variation within areas, at household level, to produce a strong general canonical coefficient.

7.6.8 Canonical Correlation Analysis using only the Three Bulk-Buying Dependent Variables and all Independent Variables

The canonical correlation analysis carried out to date has been based on the six dependent variables. The conceptual framework, subsequently confirmed by the principal components analysis, defined two sets of dependent variables based on the bulk-buying of food and the total food budget of the household. The two proposed models attempt to relate household characteristics and store usage and therefore if the three store usage variables can be separately modelled the application becomes easier. Table 37 shows a canonical correlation analysis using the

Areas	Sample Size	Eigenvalue	Canonical Correlation Coefficient	With S Lambda	Chi-Square	D.F.	Significance Level
3,5,8, 10,13	155	0.57	0.76	0.28	185.53	60	0.00
+2,14	200	0.48	0.69	0.35	202.30	60	0.00
+6,11	237	0.48	0.70	0.35	240.16	60	0.00
+4,15	290	0.44	0.66	0.42	242.19	60	0.00
+7	317	0.44	0.66	0.43	260.72	60	0.00
+1,12	365	0.42	0.64	0.45	263.03	60	0.00

TABLE 36

Canonical Correlation Coefficients for Groups of Areas

used in the Tests of Homogeneity

Area No.	Eigenvalue	Canonical Correlation Coefficient	With S Lambda	Chi-Square	D.F.	Significance Level
1	0.72	0.85	0.09	33.96	30	0.28
2	0.89	0.94	0.04	35.82	30	0.21
3	0.70	0.83	0.11	34.18	27	0.16
4	0.54	0.74	0.28	22.72	30	0.83
5	0.65	0.80	0.22	25.72	30	0.69
6	0.82	0.90	0.06	37.55	30	0.16
7	0.70	0.84	0.13	38.15	30	0.15
8	0.69	0.83	0.10	41.01	30	0.09
9	0.89	0.94	0.04	59.78	30	0.00
10	0.83	0.91	0.06	52.43	30	0.01
11	0.98	0.99	0.00	62.42	30	0.00
12	0.39	0.63	0.35	18.67	30	0.95
13	0.69	0.83	0.12	40.06	30	0.10
14	0.84	0.92	0.08	45.39	30	0.04
15	0.52	0.72	0.27	24.60	30	0.74
16 (Total)	0.28	0.53	0.66	146.14	30	0.00
Means Data Matrix	1.00	1.00	0.00	9999.00	60	0.00

TOTAL 37

Canonical Correlation Analysis for the Three Superstore Dependent Variables with Respect to the Independent Variables three store variables duration of stay (B), expenditure (D), and frequency of visit (F) and all the independent variables.

The results show strong correlation coefficients in all areas, except area 12 (Turnhouse) but eleven area relationships are not significant at the 5% level. The total data matrix canonical correlation has dropped from 0.64 to 0.53 but the means data matrix remains strong. Inspection of the canonical variable areal structure, in Table 38, again shows little stability.

7.6.9 Canonical Correlation Analysis using the three Bulk-buying Dependent Variables and three Independent Variables

The level of significance may be improved by reducing the number of independent variables. The independent variables chosen for each area are the variables, shown by the areal principal components analysis, to be the most dominant in that area. Table 39 shows the result of the analysis. The result of reducing the independent variables means that eight areas are significant at the 5% level. Seven of these areas have strong canonical correlation coefficients the eighth, area 13 (Leith), has a coefficient of 0.63. The overall coefficient has fallen by 0.02% to 0.51 implying that the additional variables do not contribute in a significant way to the equation. The results of the last three stages of the analysis, are shown in Table 40. It shows the reduction of the areal canonical correlation coefficient as variables are removed. Seven areas, areas 3 (Clermiston), 6 (Westburn), 7 (St Peters), 8 (Saughton), 9 (Craigleith Hill), 10 (Pilton), and 11 (Cammo) show consistently strong correlation coefficients but their variate structures show little uniformity. It also shows three groups of areas:

Area	Usage Index Structure of Canonical Variate	Independent Variable Structure of Canonical Variate
1	2.7F - 2.0B	0.9R + 0.6I - 0.5N - 0.5P - 0.7Q - 1.2M
2	(0.4F + 0.4B) - 1.2D	0.5J - 0.6L
3	1.4D - 0.6B - 1.3F	0.6R + 0.5M - 0.8P - 0.9O
4	1.7F - 1.3D	0.6O - 0.6L - 0.7P - 1.1M
5	1.0B - 1.3D	-1.1Q - 0.5P - 0.5R (+0.3M)
6	0.9D (-0.4B)	0.6J + 0.5M - 0.5I - 0.5N
7	1.1D + 0.5F - 0.5B	0.8K - 0.5Q - 0.9N
8	2.0B - 0.7D - 0.7F	0.8L - 0.6I - 1.5Q
9	1.0B - 1.4D	-0.7Q - 0.5I (+0.3O)
10	1.1D + 0.7F - 2.0B	0.6M - 0.8L
11	0.6D + 0.6F - 0.8B	1.3K - 0.5M - 0.5N - 0.6Q
12	0.9D + 0.5B (-0.4F)	0.7Q + 0.6R + 0.5J - 0.5N - 0.7K - 0.7L
13	2.1F - 1.9D	1.0O + 0.6N + 0.6P + 0.5K - 0.8Q
14	0.9B - 1.8D	0.9 + 0.8M - 0.6L - 1.2P
15	0.7F - 1.1B	0.9L - 0.5K - 0.5R - 0.6I
16	0.6B - 1.4D	(0.3N - 0.4K)

TABLE 38

Structure of First-Order Canonical Variates for Individual Areas using Only Three Superstore Dependent Variables

Area No.	Eigenvalue	Canonical Correlation Coefficient	With S Lambda	Chi-Square	D.F.	Significance Level
1	0.34	0.58	0.55	10.53	9	0.32
2	0.41	0.64	0.53	9.31	9	0.41
3	0.61	0.78	0.28	23.27	9	0.01
4	0.40	0.63	0.59	11.32	9	0.25
5	0.38	0.61	0.52	13.47	9	0.14
6	0.64	0.80	0.31	19.21	9	0.02
7	0.57	0.75	0.38	22.06	9	0.01
8	0.58	0.76	0.30	22.55	9	0.00
9	0.82	0.91	0.14	44.31	9	0.00
10	0.66	0.81	0.26	30.25	9	0.00
11	0.87	0.93	0.03	39.25	9	0.00
12	0.13	0.36	0.81	4.42	9	0.88
13	0.39	0.63	0.43	18.78	9	0.03
14	0.32	0.56	0.65	9.16	9	0.42
15	0.38	0.61	0.55	13.35	9	0.15
16	0.26	0.51	0.70	128.15	9	0.00

TABLE 39

Canonical Correlation Analysis with Respect to the Three Superstore Dependent Variables and Three Selected Independent Variables

Area No.	All Variables		B,D,F and All Independent Variables		B,D,F and Three Independent Variables	
	Canonical Correlation Coefficient	Level of Significance	Canonical Correlation Coefficient	Level of Significance	Canonical Correlation Coefficient	Level of Significance
1	0.94	0.29	0.85	0.28	0.58	0.32
2	0.99	0.04	0.94	0.21	0.64	0.41
3	0.96	0.03	0.83	0.16	0.78	0.01
4	0.81	0.32	0.74	0.83	0.63	0.25
5	0.77	0.52	0.80	0.69	0.61	0.14
6	0.94	0.02	0.90	0.16	0.80	0.02
7	0.82	0.01	0.84	0.15	0.75	0.01
8	0.84	0.00	0.83	0.09	0.76	0.00
9	0.92	0.01	0.94	0.00	0.91	0.00
10	0.87	0.01	0.91	0.01	0.81	0.00
11	1.00	0.00	0.99	0.00	0.93	0.00
12	0.88	0.06	0.63	0.95	0.36	0.88
13	0.92	0.03	0.83	0.10	0.63	0.03
14	0.93	0.01	0.92	0.04	0.56	0.42
15	0.93	0.04	0.72	0.74	0.61	0.15
16	0.64	0.00	0.53	0.00	0.51	0.00

TABLE 40

Canonical Correlation Analysis for -

1) All variables
2) Three Store Dependent and All Dependent Varaibles
3) Three Store Dependent and Three Independent Variables

Area No.	Pearson Correlation Coefficients					
1	E - M (0.5) E - N (0.4) E - Q (0.4) E - R (0.4)	G - N (0.4)	F - I (0.4)	D - I (0.4)	C - M (0.4)	
2	E - J (0.5) E - L (0.5) E - N (-0.6)* E - P (-0.6)* E - Q (0.7)* E - R (-0.4)	D - K (0.5) D - L (0.6)* D - M (-0.5) D - N (-0.5) D - Q (0.4) D - R (-0.4)	G - R (0.4)			
3	E - K (0.4) E - M (0.7)* E - N (-0.6)* E - O (0.4) E - P (-0.5) E - Q (0.6)	D - K (0.4)	B - H (-0.5) B - I (0.5) B - K (0.4)	G - M (0.6)* G - O (0.5)	C - K (0.5)	
4	E - H (0.3)	G - H (0.3) G - I (-0.3) G - M (0.3) G - L (-0.3)	(* shown because no correlations 0.4)			
5	E - H (0.5) E - M (0.6)* E - N (-0.4) E - Q (0.5)	D - L (0.4) D - M (0.4) D - Q (0.4)	G - H (0.4) G - M (0.4)	C - H (0.5)		
6	E - J (0.5) E - M (0.8)* E - N (-0.5) E - O (0.7)* E - P (-0.4) E - Q (0.7)*	D - H (0.5) D - J (0.5) D - M (0.6)* D - N (-0.6)* D - O (0.6)* D - Q (0.5)	B - H (0.5) B - M (0.5) B - N (-0.5) B - P (-0.5)	G - H (-0.6) G - I (0.4)	F - M (0.5)	C - H (
7	E - I (0.6)* E - K (0.6)* E - L (0.5) E - M (0.6)* E - O (0.4)	D - I (0.4) D - K (0.4) D - M (0.4) D - N (-0.4) D - O (0.4)	G - N (0.4) G - Q (0.5)	B - N (-0.5)	F - N (-0.5)	C - N (0.5)
8	E - H (-0.4) E - K (0.6)* E - L (0.4) E - M (0.7)* E - N (-0.6)* E - O (0.4) E - Q (0.6)*	C - M (0.4) C - N (-0.4)	B - I (0.4)	G - M (0.5)		

TABLE 41

Pearson Correlation Coefficients Between Dependent and Independent Variables for Individual Areas

Area No.	Pearson Correlation Coefficients					
9	E - K (0.4) E - M (0.6)* E - N (-0.6)* E - O (0.6)* E - P (-0.5) E - Q (0.5) E - R (0.4)	D - I (0.7)* D - K (0.5) D - M (0.7)* D - N (-0.6)* D - O (0.6)* D - Q (0.5)	B - H (0.4)	F - H (0.7)*	C - I (-0.4)	
10	E - K (0.4) E - M (0.6) E - N (-0.5) E - O (-0.6)* E - Q (0.5)	D - J (0.4) D - K (0.4) D - L (0.4) D - M (0.4) D - O (0.4) D - Q (0.4)	G - M (0.4)	B - L (0.5)	F - L (0.5)	C - O (0.4)
11	E - J (0.8)* E - K (0.7)* E - L (0.7)* E - M (0.7)* E - N (-0.4) E - O (0.4) E - P (-0.7)* E - Q (0.7)*	D - J (0.8)* D - K (0.7)* D - L (0.7)* D - M (0.7)* D - N (-0.5) D - P (-0.7)* D - Q (0.8)*	F - K (0.5) F - M (0.5) F - N (-0.5) F - P (-0.6)*			
12	E - M (0.5) E - O (0.4)	G - M (0.5)	C - M (0.4)			
13	E - M (0.5) E - O (0.5) E - Q (0.4)	G - M (0.4) G - O (0.5)	F - K (-0.5) F - Q (-0.4) F - R (0.4)	C - O (0.4)		
14	E - K (0.5) E - L (0.5) E - M (0.5) E - N (-0.5) E - O (0.6)*	D - O (0.4)	G - L (0.4)	C - L (0.4)		
15	E - H (-0.4) E - K (0.5) E - M (0.8)* E - N (-0.4) E - O (0.7)* E - P (-0.5)	G - H (-0.4) G - K (0.4) G - M (0.7)* G - N (-0.5) G - O (0.7)* G - P (-0.6)	B - I (0.4)	C - H (0.4) C - M (0.6)* C - N (-0.4) C - O (0.6)* C - P (-0.6)*		

TABLE 41 (Contd.)

Pearson Correlation Coefficients Between Dependent

and Independent Variables for Individual Areas

i) areas showing a strong correlation with all independent variables and with three independent variables

ii) areas showing a strong correlation with only all the independent variables

iii) area not showing a strong correlation

If the Pearson bivariate correlations are inspected, as listed in Table 41, it is evident that the expenditure dependent variables (D and E) are the variables upon which a strong canonical correlation is based. The lack of correlation in the other dependent variables is because of the small variance in their measurement.

7.6.10 Examination of the Three Groups of Areas Based on the Results of the Canonical Correlation Analysis of Paras. 7.6.8 and 7.6.9

The first group of areas comprise areas 3, 6, 7, 8, 9, 10, 11 and 13. Area 13 is added because of the strong canonical coefficient in the first two analyses :

i) Area 3 - the strong coefficient is based on total shopping variables E and G therefore the coefficient drops when these are omitted.

ii) Area 7 - the expenditure variables E and D are the basis of the relationship.

iii) Area 8 - the total expenditure variable E is dominant.

iv) Area 9 - the expenditure variables E and D are dominant.

v) Area 10 - as for area 9.

vi) Area 11 - the expenditure variables D and E again strong in addition to the frequency of use of store variable F.

vii) Area 13 - the absence of the store expenditure variable D accounts for the decrease in the coefficient.

The second group of areas comprises areas 2, 12, 14 and 15

i) Area 2 - expenditure variables D and E are dominant

ii) Area 12 - no relationship with any of the store variables B, D, F.

iii) Area 14 - again B, D and F almost totally absent.

iv) Area 15 - as for area 14.

The last group of areas comprises areas 1, 4 and 5 :

i) Area 1 - very little relationship shown with the store variables B, D, F.

ii) Area 4 - no relationship with B, D, F.

iii) Area 5 - the relationship with the expenditure variables is dominant.

From inspection of Table 41 it can be seen that the expenditure variables D and E form the basis of strong areal canonical correlations. In group two the reliance on the total shopping variables produces a reduction in the coefficient when they are removed. Group three requires all six dependent variables to achieve a strong correlation.

7.6.11 The canonical correlation analysis has established that a strong relationship exists, in each area, between the dependent and independent variables but that the structure of the relationship differs from area to area. The result of this variation is that on aggregation the canonical correlation coefficient is reduced. Thus the conclusion of the principal components analysis is supported by this analysis that a generalised model at household level using either of the proposed models will not produce a satisfactory prediction model.

The means data matrix however, continues to show a strong correlation between the variable sets and an areal model based on the mean profile of each area is possible.

7.7 Examination of Area Groupings using Cluster Analysis

7.7.1 The third research objective and consequent research task addressed the problem of generality of the model and required the analysis to determine the level of disaggregation possible while still retaining a strong predictive relationship between the dependent and independent variables. The principal components analysis and canonical correlation analysis showed that the areal variation between households was of such diversity that a general model structure was not possible. The means profiles of each area, however, did provide the basis for a general model but this model relates to average area values. In the context of a strategic control model this is acceptable and compares with the zoning system of a conventional transportation model.

7.7.2 Certain areas did show similarities and before developing the predictive models, using multiple regression analysis, the middle-ground of aggregated area groupings should be examined using cluster analysis. It is apparent, from the canonical correlation analysis, that certain groups of areas have similar variable poles to their canonical variates. If the dependent variate poles are inspected the following is shown :

<u>All Dependent Variables</u>

Four areas (3,6,8,15)	have D-E as opposite poles
Three areas (2,4,13)	have D-F as opposite poles
Three areas (9,11,14)	have D-B as opposite poles
Two areas (5,10)	have C-G as opposite poles
One area (7)	has E-G as opposite poles
One area (12)	has B-C as opposite poles
One area (1)	has B-F as opposite poles

The immediate points of interest to note in these groupings is the continuing dominance of the two shopping expenditure variables D and E and the continuing isolation of area 1 (Moredun) and area 12 (Turnhouse).

If only the three store variables are included the following is shown :

<u>Three Store Variables</u>

Seven areas (5,6,7,9,10,11,14)	have D-F as opposite poles
Five areas (2,3,4,12,13)	have D-B as opposite poles
Three areas (1,8,15)	have B-F as opposite poles.

7.7.3 The area groups using all six dependent variables exhibit common characteristics in that areas 3,6,8 and 15 are predominantly council-rented housing whereas 9, 11, and 14 are private housing. Areas 5 and 10 are areas of social deprivation. This socio-economic form of classification does not show for the three store variables.

7.7.4 A canonical correlation analysis was carried out on the four aggregated groups of areas which relate to the six dependent variables. The correlation coefficients for each group are as follows :

Areas 3, 6, 8, 15	0.79
Areas 2, 4, 13	0.60
Areas 9, 11, 14	0.78
Areas 5, 10	0.82

The diluting effect of aggregation is again evident in these results although the 0.79 value for areas 3, 6, 8 and 15 has remained relatively strong, explaining over 60% of the variance in the variables. The conceptual basis of these groups is however superficial and is not rigorous in that other council-rented areas such as area 10 (Pilton) are not included.

7.7.5 Cluster analysis was used to determine the minimum number of groups for which significance could be achieved at the 5% level. The analysis is based on the formula :

$$F(c_1, c_2) = \frac{Rc_1 - Rc_2}{Rc_2} \Big/ \frac{n - c_1}{n - c_2} \left(\frac{c_2}{c_1}\right)^{2/p} - 1\}$$

where R_{c_1} = residual sum of squares for clustering combination 1.

R_{c_2} = residual sum of squares for clustering combination 2.

(Note : $c_2 > c_1$)

$p(n - c_1)$ = numerator μ_1 in F-test

$p(n - c_2)$ = numerator μ_2 in F-test (i.e. degrees of freedom)

p = number of variables

n = number of areas.

Thus between 1 and 2 clusters :

$$F(c_1, c_2) = \frac{1595.41 - 978.29}{978.29} / \{ \frac{15 - 1}{15 - 2} \quad \frac{2}{1}^{2/16} -1 \}$$

$$= 0.63/1.08\ (0.92) - 1$$

$$= 3.5$$

μ_1 = 16(1) = 16 at 5% level 1.6. which is
μ_2 = 16(15-2) = 208 → significant

Between 2 and 3 clusters:

$$F(c_1, c_2) = \frac{978.29 - 697.28}{697.28} / \{ \frac{15 - 2}{15 - 3} \quad (\frac{3}{2})^{0.125} -1 \}$$

$$= 0.40\ /1.08\ (1.84) - 1$$

$$= 0.4$$

μ_1 = 16(1) = 16 at 5% level 1.6. which is
μ_2 = 16(15-2) = 208 → significant

7.7.6 The two significant clusters comprised areas 1, 2, 3, 5, 8, 9 and 14 and areas 4, 6, 7, 10, 11, 12, 13 and 15. Inspection of each group characteristics provides no meaningful classification and only marginally improves the overall canonical coefficient. Thus although the cluster analysis provides significant clusters at the two cluster level, no meaningful interpretation can be ascribed to these clusters.

7.7.7 A further basis for the grouping of areas can be argued on store usage level, grouping areas of similar usage. This can be achieved using either duration of stay, expenditure or frequency of visit. Tables 42, 43 and 44 show the areas in order of duration of stay, expenditure and frequency of visit to stores respectively. These tables show the linear relationship between certain independent variables and store usage and how this relationship can be affected by a dominant area characteristic. For example four variables are plotted against area number in Figure 24. With each of these variables a linear trend can be seen but, for example area 6 (Westburn) appears to be consistently misplaced. It is an area of low income, freezer ownership and car ownership and yet it has a high store usage. This is because of the proximity of the area to a large store and the large number of walking trips that take place. This is reflected in the spatial accessibility index of 19.6. A further example is in Table 44 and area 9 (Craigleith Hill Avenue). This is in an area of high income and car and freezer ownership, however the low number in the household and the high average age indicates that there is a significant group of retired couples in this area whose food requirement is low. The area is therefore displaced further down the usage table. This exercise can be carried out for all areas and further supports the analysis results to date in that it shows the interplay

	Area	B	C	D	E	F	G	S	I	J	K	L	M	N	O	P	Q	R
12	Turnhouse	1.3	2.4 (0.54)	28.1	38.1 (0.74)	1.1	2.5 (0.44)	0.8	0.7	1.2	4.0	1.8	3.3	31.1	12.2	6.4	13.9	12.7
15	Easter Rd/ Dalry	1.2	2.3 (0.52)	20.1	29.6 (0.48)	1.1	2.8 (0.39)	1.2	0.3	1.1	2.9	1.3	2.9	37.1	9.4	10.3	9.5	12.7
11	Cammo	1.1	2.0 (0.55)	26.3	34.1 (0.77)	1.1	2.6 (0.42)	1.6	0.9	1.7	4.9	2.1	3.2	43.3	14.1	8.1	11.6	15.4
14	Craigleith Cres/ View	1.1	2.1 (0.52)	25.8	38.2 (0.68)	1.0	2.6 (0.38)	1.2	0.9	1.3	4.7	1.8	2.9	49.1	9.1	9.3	8.7	15.0
4	Swanston	1.1	2.3 (0.48)	21.0	31.2 (0.67)	0.9	2.1 (0.43)	0.5	0.7	1.4	4.0	1.9	3.2	38.7	12.0	7.4	12.5	13.7
13	Leith	1.1	3.4 (0.32)	16.7	32.1 (0.52)	0.8	2.8 (0.29)	0.8	0.2	1.1	2.9	1.3	3.5	38.6	13.2	11.0	10.5	10.9
6	Westburn Park	1.0	1.6	28.2	32.9	1.1	2.1	19.6	0.2	1.0	2.8	1.3	3.4	31.4	12.7	10.6	12.5	11.4
8	Saughton Mains	1.0	2.5 (0.40)	21.6	37.3 (0.58)	0.9	2.7 (0.33)	1.8	0.7	1.1	3.5	1.4	3.3	48.5	11.8	12.3	16.4	12.2
3	Clermiston	1.0	2.0 (0.5)	15.7	27.5 (0.57)	0.7	1.8 (0.39)	1.5	0.3	1.0	2.7	1.2	2.3	51.4	4.4	9.9	13.2	11.7
7	St Peters Pl	0.9	1.6 (0.56)	20.8	28.8 (0.72)	0.8	1.9 (0.42)	3.2	0.5	1.2	3.6	1.6	2.5	30.1	7.6	7.4	12.8	10.2
9	Craigleith Hill Ave	0.9	1.8 (0.5)	18.7	26.3 (0.71)	0.7	1.7 (0.41)	1.1	0.6	1.2	3.8	1.5	2.9	43.6	11.4	10.0	12.9	11.1
1	Moredun	0.9	1.9 (0.47)	17.9	30.0 (0.60)	0.7	1.8 (0.39)	0.4	0.6	1.0	2.7	1.4	2.9	44.9	11.4	11.7	9.1	13.0
2	Spottiswoode	0.9	2.0 (0.45)	17.0	29.2 (0.58)	0.6	2.4 (0.25)	2.0	0.5	1.1	2.6	1.3	2.3	46.0	8.4	12.4	8.2	13.3
5	Wav./Reg.Pl	0.9	2.6 (0.35)	13.9	26.4 (0.53)	0.7	3.6 (0.19)	1.6	0.4	1.0	2.2	1.0	2.4	52.4	6.4	12.4	6.2	11.6
10	Pilton	0.8	2.6 (0.31)	18.5	38.1 (0.49)	0.6	3.1 (0.19)	1.3	0.4	1.1	2.6	1.3	3.6	41.3	8.8	11.7	13.1	10.7
16	All Areas	1.0	2.2 (0.45)	20.6	32.0	0.8	2.4	-	0.5	1.2	3.3	1.5	3.0	41.7	10.1	10.0	11.5	12.3

B = Hours/Week at Store
C = Total Hours/Week
D = Expenditure/Week at Store
E = Total Expenditure per week
F = Frequency/Week at Store
G = Total Frequency/Week

S = Spatial Access
I = Freezer Ownership
J = Number of Cars
K = Income
L = Number of Licences
M = Number in Household

N = Mean Age of Household
O = S.D. of Ages
P = S.E.G.
Q - Number of half days employed
R = Personal Accessibility

TABLE 42

Means Data Matrix in Order of Store Duration of Stay

Area		B	C	D	E	F	G	S	I	J	K	L	M	N	O	P	Q	R
5	Wav./Reg.Pl	0.9	2.6	13.9	26.4	0.7	3.6	1.6	0.4	1.0	2.2	1.0	2.4	52.4	6.4	12.4	6.2	11.6
3	Clermiston	1.0	2.0	15.7	27.5	0.7	1.8	1.5	0.3	1.0	2.7	1.2	2.3	51.4	4.4	9.9	13.2	11.7
2	Spottiswoode	0.9	2.0	17.0	29.2	0.6	2.4	2.0	0.5	1.1	2.6	1.3	2.3	46.0	8.4	12.4	8.2	13.3
13	Leith	1.1	3.4	16.7	32.1	0.8	2.8	0.8	0.2	1.1	2.9	1.3	3.5	38.6	13.2	11.0	10.5	10.9
1	Moredun	0.9	1.9	17.9	30.0	0.7	1.8	0.4	0.6	1.0	2.7	1.4	2.9	44.9	11.4	11.7	9.1	13.0
10	Pilton	0.8	2.6	18.5	38.1	0.6	3.1	1.3	0.4	1.1	2.6	1.3	3.6	41.3	8.8	11.7	13.1	10.7
9	Craigleith Hill Ave	0.9	1.8	18.7	26.3	0.7	1.7	1.1	0.6	1.2	3.8	1.5	2.9	43.6	11.4	10.0	12.9	11.1
15	Easter Rd/Dalry	1.2	2.3	2.0	29.6	1.1	2.8	1.2	0.3	1.1	2.9	1.3	2.9	37.1	9.4	10.3	9.5	12.7
7	St Peters Pl	0.9	1.6	20.8	28.8	0.8	1.9	3.2	0.5	1.2	3.6	1.6	2.5	30.1	7.6	7.4	12.8	10.2
4	Swanston	1.1	2.3	21.0	31.2	0.9	2.1	0.5	0.7	1.4	4.0	1.9	3.2	38.7	12.0	7.4	12.5	13.7
8	Saughton Mains	1.0	2.5	21.6	37.3	0.9	2.7	1.8	0.7	1.1	3.5	1.4	3.3	48.5	11.8	12.3	16.4	12.2
14	Craigleith Cres/ View	1.1	2.1	25.8	38.2	1.0	2.6	1.2	0.9	1.3	4.7	1.8	2.9	49.1	9.1	9.3	8.7	15.0
11	Cammo	1.1	2.0	26.3	34.1	1.1	2.6	1.6	0.9	1.7	4.9	2.1	3.2	43.3	14.1	8.1	11.6	15.4
6	Westburn Park	1.0	1.6	28.2	32.9	1.1	2.1	19.6	0.2	1.0	2.8	1.3	3.4	31.4	12.7	10.6	12.5	11.4
12	Turnhouse	1.3	2.4	28.1	38.1	1.1	2.5	0.8	0.7	1.2	4.0	1.8	3.3	31.1	12.2	6.4	13.9	12.7
16	All Areas	1.0	2.2	20.6	32.0	0.8	2.4	-	0.5	1.2	3.3	1.5	3.0	41.7	10.1	10.0	11.5	12.3

B = Hours/Week at Store
C = Total Hours/Week
D = Expenditure/Week at Store
E = Total Expenditure per week
F = Frequency/Week at Store
G = Total Frequency/Week

S = Spatial Access
I = Freezer Ownership
J = Number of Cars
K = Income
L = Number of Licences
M = Number in Household

N = Mean Age of Household
O = S.D. of Ages
P = S.E.G.
Q - Number of half days employed
R = Personal Accessibility

TABLE 43

Means Data Matrix in Order of Store Expenditure

Area		B	C	D	E	F	G	S	I	J	K	L	M	N	O	P	Q	R
12	Turnhouse	1.3	2.4	28.1	38.1	1.1	2.5	0.8	0.7	1.2	4.0	1.8	3.3	31.1	12.2	6.4	13.9	12.7
6	Westburn Park	1.0	1.6	28.2	32.9	1.1	2.1	19.6	0.2	1.0	2.8	1.3	3.4	31.4	12.7	10.6	12.5	11.4
11	Cammo	1.1	2.0	26.3	34.1	1.1	2.6	1.6	0.9	1.7	4.9	2.1	3.2	43.3	14.1	8.1	11.6	15.4
15	Easter Rd/Dalry	1.2	2.3	20.1	29.6	1.1	2.8	1.2	0.3	1.1	2.9	1.3	2.9	37.1	9.4	10.3	9.5	12.7
14	Craigleith Cres/ View	1.1	2.1	25.8	38.2	1.0	2.6	1.2	0.9	1.3	4.7	1.8	2.9	49.1	9.1	9.3	8.7	15.0
8	Saughton Mains	1.0	2.5	21.6	37.3	0.9	2.7	1.8	0.7	1.1	3.5	1.4	3.3	48.5	11.8	12.3	16.4	12.2
4	Swanston	1.1	2.3	21.0	31.2	0.9	2.1	0.5	0.7	1.4	4.0	1.9	3.2	38.7	12.0	7.4	12.5	13.7
7	St Peters Pl	0.9	1.6	20.8	28.8	0.8	1.9	3.2	0.5	1.2	3.6	1.6	2.5	30.1	7.6	7.4	12.8	10.2
13	Leith	1.1	3.4	16.7	32.1	0.8	2.8	0.8	0.2	1.1	2.9	1.3	3.5	38.6	13.2	11.0	10.5	10.9
9	Craigleith Hill Ave	0.9	1.8	18.7	26.3	0.7	1.7	1.1	0.6	1.2	3.8	1.5	2.9	43.6	11.4	10.0	12.9	11.1
1	Moredun	0.9	1.9	17.9	30.0	0.7	1.8	0.4	0.6	1.0	2.7	1.4	2.9	44.9	11.4	11.7	9.1	13.0
3	Clermiston	1.0	2.0	15.7	27.5	0.7	1.8	1.5	0.3	1.0	2.7	1.2	2.3	51.4	4.4	9.9	13.2	11.7
5	Wav./Reg.Pl	0.9	2.6	13.9	26.4	0.7	3.6	1.6	0.4	1.0	2.2	1.0	2.4	52.4	6.4	12.4	6.2	11.6
2	Spottiswoode	0.9	2.0	17.0	29.2	0.6	2.4	2.0	0.5	1.1	2.6	1.3	2.3	46.0	8.4	12.4	8.2	13.3
10	Pilton	0.9	2.6	18.5	38.1	0.6	3.1	1.3	0.4	1.1	2.6	1.3	3.6	41.3	8.8	11.7	13.1	10.7
16	All Areas	1.0	2.2	20.6	32.0	0.8	2.4	-	0.5	1.2	3.3	1.5	3.0	41.7	10.1	10.0	11.5	12.3

B = Hours/Week at Store
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S = Spatial Access
I = Freezer Ownership
J = Number of Cars
K = Income
L = Number of Licences
M = Number in Household

N = Mean Age of Household
O = S.D. of Ages
P = S.E.G.
Q - Number of half days employed
R = Personal Accessibility

TABLE 44

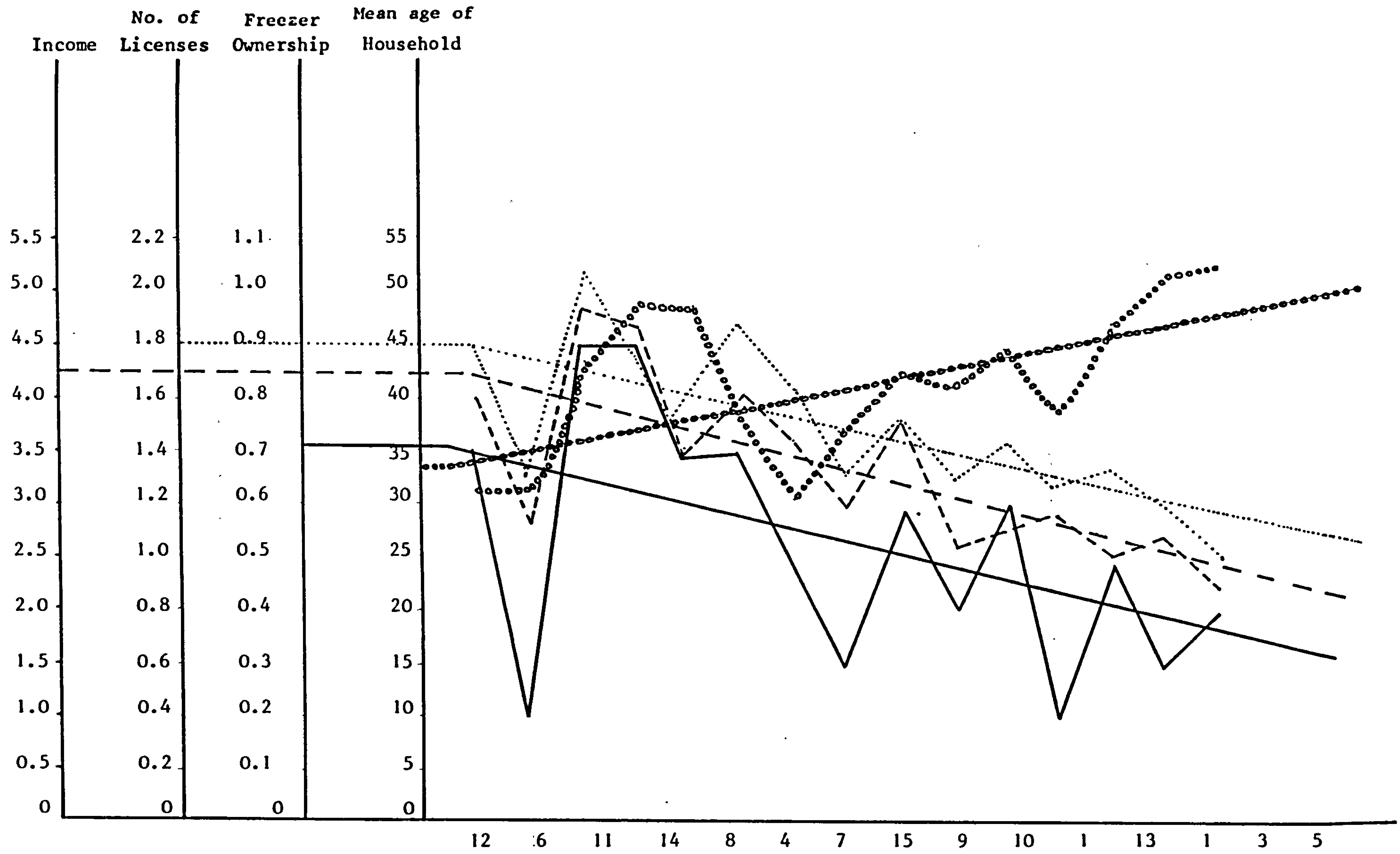


FIGURE 24

Freezer ownership, income, number of licences and mean age of the household with respect to expenditure at large foodstores between the independent variables. The linear trend however also supports the relationship established by the canonical correlation analysis and indicates that a model based on multiple regression is possible, albeit not based at household level.

7.7.8 This section of the analysis has found no basis for classification of areas into usage groups. A range of classification criteria can be selected and each yields a different set of groups. For example, if the three store usage variables were added together, unweighted, and grouped on three usage classifications of high, medium and low, a possible grouping would be :

High	-	areas 6, 11, 14, 12
Medium	-	areas 1, 2, 3, 5, 13
Low	-	areas 4, 8, 9, 10, 7, 15

These areas group bear no resemblance to the previously established groups, based on cluster analysis or canonical variates. A canonical correlation analysis was carried out on these groupings and the effect of area aggregation on the correlation coefficient again observed. Table 45 shows the details. There is therefore no satisfactory justification for developing this approach.

7.8 Prediction of the Store Dependent Variables using Multiple Regression Analysis

7.8.1 This section of the analysis concerns the development of a predictive model using multiple regression analysis. The two models identified in the conceptual framework will be analysed to investigate their development into a strategic trip generation model for private car trips to large foodstores. The first model to be examined is Model 2 which is based on the individual variables. The three dependent variables of greatest interest are duration of

Areas	Canonical Correlation Coefficient
6, 11, 14	0.77
6, 11, 14, 12	0.72
1, 2, 3, 5	0.68
1, 2, 3, 5, 13	0.62
1, 2, 3	0.72
4, 8, 9	0.72
4, 8, 9, 10	0.74
4, 8, 9, 10, 7, 13	0.68

TABLE 45

Canonical Correlation Analysis for Groups of Areas

Based on an Aggregate Store Usage Index

stay at the store (B), expenditure at the store (D) and frequency of visit to the store (F). This model has the advantage that trip generation, car park capacity and market potential can be modelled separately using frequency (F), duration (B) and expenditure (D) respectively.

7.8.2 Multiple Regression Analysis of the Individual Areas using Model 2

The details of the multiple regression analysis for each area are shown in Appendix H. This shows a step-wise analysis for each of the three dependent store variables with the independent variables and frequency of use (F) with duration of stay (B) and expenditure (D). The asterisked values are those proved significant using the F-test.

It can be clearly seen from inspection of the appendix that the three dependent variables are strongly correlated in all areas. It is therefore possible to predict one of these variables from the other two variables at household level. The prediction of the individual dependent variables from the independent variables shows the areal variation corresponding to that found by the previous stages of the analysis.

The store expenditure variable (D) is the one variable which shows a relationship with the independent variables. Its multiple correlation coefficient varies from 23% to 95% and is significant in ten areas. This again shows the dominance of store expenditure in the dependent/independent relationships.

As expected, the prediction mechanism varies from area to area and does not show either a standard structure or groups of standard structures. Tables 46 to 48 show the

Frequency with I - R			
Area	1	F =	I Q O K R J L N P N
Area	2	F =	R I O M L P J K
Area	3	F =	O K R I Q M P L
Area	4	F =	P M N R L O K Q K I
Area	5	F =	Q O K J P L M
Area	6	F =	M J I O L R K Q N
Area	7	F =	N Q K P L M R I O
Area	8	F =	I R M Q P L J O N K
Area	9	F =	N Q I J R M P O L
Area	10	F =	L I R J Q K O M P
Area	11	F =	P L J O I Q R M K N
Area	12	F =	M J N K Q R L O
Area	13	F =	L R N O J K P M I Q
Area	14	F =	O Q K M J R I L P N
Area	15	F =	P J Q N I O R
Area	16	F =	K Q N M R I J P O

TABLE 46

Order of Variable Addition in the Multiple Regression Analysis

for F with I to R by Individual Area

Duration with I - R			
Area	1	B =	I Q K J R M N P
Area	2	B =	R P J O M N L Q
Area	3	B =	I K R O P N Q M
Area	4	B =	M N I R O P K J
Area	5	B =	K M O R N J Q P I
Area	6	B =	M I O J K Q L R N
Area	7	B =	N K Q P M L R J O
Area	8	B =	I R L Q M P O N
Area	9	B =	R Q M J O L N P K I
Area	10	B =	L I R Q J O M N P
Area	11	B =	K Q M R L J O N P I
Area	12	B =	N K J Q M O P I L R
Area	13	B =	P R L Q O J K N M I
Area	14	B =	P K N M R Q J K I O
Area	15	B =	I L J R O K M N P
Area	16	B =	N Q K I M R O J L P

TABLE 47

Order of Variable Addition in the Multiple Regression Analysis for B with I to R by Individual Area

Expenditure with I - R				
Area	1	D	=	I Q O K L P J M N
Area	2	D	=	L R O M J Q K P
Area	3	D	=	K O M R P I Q N
Area	4	D	=	R J I M N K P L O
Area	5	D	=	Q P L R I M N J K O
Area	6	D	=	M J I K R Q L O N P
Area	7	D	=	K N R Q I P O M J L
Area	8	D	=	O R I P J K Q M N
Area	9	D	=	M I N J L O R P
Area	10	D	=	O K L J I R P
Area	11	D	=	J P O Q R L K N I M
Area	12	D	=	J N M Q K L R I P
Area	13	D	=	L R P N O Q M J K I
Area	14	D	=	O P K M N L J I Q R
Area	15	D	=	L K J P I M Q R O
Area	16	D	=	K M I N R P L J O

TABLE 48

Order of Variable Addition in the Multiple Regression Analysis for D with I to R for Individual Areas order of variables chosen in each area by the step-wise regression for each of the three dependent variables. The standardised residual plots and the observed and predicted dependent variable values for each area are shown in Appendix I. An analysis of the residuals is carried out later in this section of the analysis.

7.8.3 Interpretation of the Multiple Regression Analysis at Individual Area Level with respect to the Pearson Correlation Matrices

The areal variation that has been observed at each stage of the analysis can be understood from inspection of the Pearson correlation matrices shown, for each area, in Tables 49 to 64. These tables show correlation coefficients greater than or equal to 0.4 and significant at the 5% level.

The upper-right quartile of the tables shows the number and strength of the relationships between the dependent and independent variables. A strong multiple correlation coefficient can be achieved either by a number of correlated variables of medium strength or by one or two strongly correlated variables. For example in area 2 (Spottiswoode) store expenditure (D) has a correlation coefficient of 0.78, 61% of its variation being explained by the independent variables. Table 50 shows that this relationship is achieved from six moderately correlated independent variables.

The areas that have consistently shown a poor relationship between the two variable sets and those areas exhibiting a strong relationship can also be seen from the tables. Areas 1 (Moredun) and 12 (Turnhouse) show virtually no significant correlations between the store variables B, D and F and the independent variables, whereas areas 9 (Craigleith Hill) and 11 (Cammo) show strong correlations

Area – 1 (Moredun)	Significant Pearson Correlations Over 0.4															
	(-1.9) B	(0.2) C	(0.1) D	(-0.6) E	(1.8) F	(-0.3) G	(0.4) I	(0.1) J	(-0.1) K	(0.3) L	(-1.2) M	(-1.4) N	(0) O	(-0.2) P	(-0.4) Q	(0.6) R
B(-1.9)	1	x	0.8	x	0.9	x	x	x	x	x	x	x	x	x	x	x
C(0.2)		1	x	0.4	x	0.8	x	x	x	x	0.4	-0.4	x	x	x	x
D(0.1)			1	x	0.9	-0.4	0.4	x	x	x	x	x	x	x	x	x
E(-0.6)				1	x	x	x	x	x	x	0.5	-0.4	x	x	-0.4	-0.4
F(1.8)					1	x	0.4	x	x	x	x	x	x	x	x	x
G(-0.3)						1	x	x	x	x	x	-0.4	x	x	x	x
I(0.4)							1	x	x	x	x	x	x	x	x	x
J(0.4)								1	0.5	x	x	x	0.4	x	x	x
K(-0.1)									1	x	x	-0.5	x	-0.8	x	-0.5
L(0.3)										1	x	x	x	x	x	x
M(-1.2)											1	-0.6	0.8	-0.5	x	x
N(-0.4)												1	-0.5	0.8	x	0.5
O(0)													1	x	x	x
P(-0.2)														1	x	0.7
Q(-0.4)															1	x
R(0.6)																1

TABLE 49

Multiple Regression Analysis – Table of Pearson Correlation Coefficients

by Individual Area

Area - 2 (Spottiswoode)	Significant Pearson Correlations Over 0 4															
	(1.0) B	(-0.8) C	(1.2) D	(-0.7) E	(-1.6) F	(0.4) G	(0 3) I	(-0.6) J	(0.1) K	(0.4) L	(0.9) M	(0 1) N	(-0.8) O	(0.5) P	(0.2) Q	(-0.2) R
B(1.0)	1	x	0.5	x	0.8	x	x	x	x	x	x	x	x	x	x	x
C(-0 8)		1	x	x	x	0.7	x	x	x	x	x	x	x	x	x	x
D(1.2)			1	0.5	0.5	-0.6	x	x	0.5	0.6	0.4	-0.5	x	-0.4	0.4	x
E(-0.7)				1	x	x	x	0.5	0.9	0.5	x	-0.6	x	-0.6	0.7	-0.4
F(-1.6)					1	-0.5	x	x	x	x	x	x	x	x	x	x
G(0.4)						1	x	x	x	x	x	x	x	x	x	x
I(0.3)							1	x	0.5	x	x	x	x	x	x	x
J(-0 6)								1	0.4	x	x	x	x	x	0.5	x
K(0.1)									1	0.6	x	-0.5	x	-0.6	0.7	x
L(0.4)										1	0.7	-0.6	0.6	x	0 5	x
M(0.9)											1	-0.5	0.9	x	0.6	x
N(0.1)												1	-0.4	0.6	-0.6	0.6
O(-0.8)													1	x	0.5	x
P(0.5)														1	-0.6	0.5
Q(0.2)															1	x
R(-0.2)																1

TABLE 50

Multiple Regression Analysis - Table of Pearson Correlation Coefficients

by Individual Area

Area - 3 (Clermiston)	Significant Pearson Correlations Over 0.4															
	(0.4) B	(0.1) C	(-1.3) D	(1 1) E	(0.2) F	(-0.1) G	(0.2) I	(0.0) J	(0.4) K	(0.0) L	(0:9) M	(0.1) N	(-0.3) O	(-0.6) P	(0.2) Q	(0.7) R
B(0.4)	1	0.5	0.7	x	0.8	x	0.5	-	0.4	x	x	x	x	x	x	x
C(0 1)		1	0.4	0.5	0.4	0 7	x	-	0.5	x	x	x	x	x	x	x
D(-0.3)			1	0.6	0.8	0.4	x	-	0.4	x	x	x	x	x	x	x
E(1.1)				1	x	0.7	x	-	0.4	x	0.7	-0.6	0.4	-0.5	0.6	x
F(-1.2)					1	x	x	-	x	x	x	x	x	x	x	x
G(-0 1)						1	x	-	x	x	0.6	x	0.5	x	x	x
I(0.2)							1	-	0.4	x	x	x	x	x	x	x
J(0.0)	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
K(0.4)								-	1	x	x	-0.4	x	-0.6	0.4	-0.5
L(0 0)								-		1	x	x	0.5	x	0.4	x
M(0.9)								-			1	-0.7	0.8	x	0 6	x
N(0.1)												1	-0.6	0.4	0.6	0.4
O(-0.3)													1	-0.4	0.5	x
P(-0.6)														1	-0.6	0.7
Q(0.2)															1	x
R(0.7)																1

TABLE 51

Multiple Regression Analysis - Table of Pearson Correlation Coefficients

by Individual Area

Area - 4 (Swanston)	Significant Pearson Correlations Over 0.4															
	(0.0) B	(-0.4) C	(1.6) D	(-0.7) E	(-1.3) F	(1.3) G	(-0.3) I	(-0.3) J	(0.0) K	(0.1) L	(1.4) M	(0.7) N	(-0 5) O	(0.0) P	(0.2) Q	(0.1) R
B(0.0)	1	0.5	0.7	x	0.8	x	0.5	-	0.4	x	x	x	x	x	x	x
C(-0.4)		1	0.4	0.5	0.4	0.7	x	-	0.5	x	x	x	x	x	x	x
D(1.6)			1	0.6	0.8	0.4	x	-	0.4	x	x	x	x	x	x	x
E(-0.7)				1	x	0.7	x	-	0.4	x	0.7	-0.6	0.4	-0.5	0.6	x
F(-1.3)					1	x	x	-	x	x	x	x	x	x	x	x
G(1.3)						1	x	-	x	x	0.6	x	0.5	x	x	x
I(-0.3)							1	-	0.4	x	x	x	x	x	x	x
J(-0.3)	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
K(0.0)								-	1	x	x	-0.4	x	-0.6	0.4	-0.5
L(0.1)								-		1	x	x	0.5	x	0.4	x
M(1.4)								-			1	-0.7	0.8	x	0.6	x
N(0.7)												1	-0.6	0.4	0.6	0.4
O(-0.5)													1	-0.4	0.5	x
P(0.0)														1	-0.6	0.7
Q(0.2)															1	x
R(0.1)																1

TABLE 52

Multiple Regression Analysis - Table of Pearson Correlation Coefficients

by Individual Area

Area - 5 (Wav./Reg.Place)								Significant Pearson Correlations Over 0.4								
	(-0.3) B	(-0.8) C	(1.3) D	(-0.3) E	(-0.4) F	(1.5) G	(0.1) I	(0.4) J	(-0.2) K	(0.4) L	(0.1) M	(-0.8) N	(-0.7) O	(0.5) P	(1.0) Q	(0.5) R
B(-0.3)	1	x	0.7	x	0.7	x	x	x	x	x	x	x	x	x	x	x
C(-0.8)		1	x	0.8	x	0.9	0.4	x	x	x	x	x	x	x	x	x
D(1.3)			1	0.4	0.7	x	x	x	x	0.4	0.4	x	x	x	0.4	x
E(-0.3)				1	x	0.8	x	x	x	x	0.6	-0.4	0.3	x	0.5	x
F(-0.4)					1	x	x	x	x	x	x	x	x	x	0.3	x
G(1.5)						1	0.4	x	x	x	0.4	x	x	x	x	x
I(0.1)							1	x	x	x	x	-0.4	0.4	x	-0.4	-0.4
J(0.4)								1	0.7	0.8	x	x	x	-0.4	0.4	x
K(-0.2)									1	0.7	0.6	-0.6	0.6	-0.7	0.6	-0.4
L(0.4)								-		1	0.4	x	0 5	-0.5	0.5	x
M(0.1)								-			1	-0.9	0.8	-0.6	0.8	-0.5
N(-0.8)												1	-0.8	0.7	-0.8	0.7
O(-0.7)													1	-0.7	0.8	-0.6
P(0.5)														1	-0.8	0.6
Q(1.0)															1	-0.7
R(0.5)																1

TABLE 53

Multiple Regression Analysis - Table of Pearson Correlation Coefficients

by Individual Area

Area - 6 (WestBurn)	Significant Pearson Correlations Over 0.4															
	(0.0) B	(1.0) C	(-2.7) D	(1.5) E	(0.1) F	(-2.4) G	(0.2) I	(-0.5) J	(-0.4) K	(0.0) L	(-0.8) M	(-0.6) N	(0.0) O	(-0.1) P	(-1.1) Q	(-0.3) R
B(0.0)	1	x	0.6	0.6	0.9	x	x	x	x	x	0.5	-0.5	x	-0.5	0.4	x
C(1.0)		1	x	x	x	0.9	x	x	x	x	0.4	x	x	x	x	x
D(-2.7)			1	0.9	0.6	-0.4	x	0.5	x	x	0.6	-0.6	0.6	x	0.5	x
E(1.5)				1	0.6	x	x	0.5	0.4	x	0.8	-0.6	0.7	-0.4	0.7	x
F(0.1)					1	x	x	0.4	x	x	0.5	x	x	x	x	x
G(-2.4)						1	0.4	x	x	x	x	x	x	x	x	x
I(0.2)							1	0.5	x	x	x	x	x	x	0.4	x
J(-0.5)								1	x	x	x	x	x	x	0.4	x
K(-0.4)									1	x	x	-0.4	0.4	x	x	-0.4
L(0.0)								-		1	x	x	x	x	x	0.4
M(-0.8)								-			1	-0.5	0.6	-0.5	0.7	x
N(-0.6)												1	-0.6	0.8	-0.5	0.4
O(0.0)													1	x	0.5	-0.4
P(-0.1)														1	-0.6	x
Q(-0.1)															1	x
R(-0.3)																1

TABLE 54

Multiple Regression Analysis - Table of Pearson Correlation Coefficients

by Individual Area

Area – 7 (St. Peters)						Significant Pearson Correlations Over 0.4										
	(-0.2) B	(-1.4) C	(-0.2) D	(1.3) E	(1.3) F	(-0.6) G	(0.4) I	(0.1) J	(0.7) K	(0.7) L	(0.1) M	(-0.7) N	(-0.2) O	(-0.2) P	(-0.4) Q	(0.2) R
B(-0.2)	1	x	0.8	0.4	0.9	-0.4	x	x	x	x	x	-0.5	0.4	x	x	x
C(-1.4)		1	x	0.4	x	0 5	x	x	x	x	x	0.5	x	x	x	x
D(-0.2)			1	0.6	0.6	-0.3	0.4	x	0.4	x	0.4	-0.4	0.4	x	x	x
E(1.3)				1	x	0.5	0.6	x	0.6	0.5	0.6	0.4	x	x	x	x
F(1.3)					1	-0.4	x	x	x	x	x	-0.5	x	x	x	x
G(-0.6)						1	x	x	x	x	x	0.4	x	x	0.5	x
I(0.4)							1	0.4	0.6	0.4	0.4	x	0.4	-0.3	0.4	x
J(0.1)								1	0.5	0.3	x	x	0.5	x	0.5	x
K(0.7)									1	0.4	0.4	x	0.5	-0.6	0.5	x
L(0.2)								–		1	0.5	x	x	x	0.5	0.3
M(0.1)								–			1	x	0.7	x	0.3	x
N(-0.7)												1	x	x	x	0.4
O(-0.2)													1	x	x	x
P(0.2)														1	-0.4	x
Q(-0.4)															1	x
R(0.2)																1

TABLE 55

Multiple Regression Analysis – Table of Pearson Correlation Coefficients

by Individual Area

Area - 8 (Saughton)	Significant Pearson Correlations Over 0.4															
	(-0.9) B	(0.9) C	(1.6) D	(1.8) E	(-1.1) F	(-0.4) G	(0.3) I	(0.1) J	(0.0) K	(-0.2) L	(-1.0) M	(0.4) N	(0.4) O	(-0.4) P	(0.0) Q	(0.1) R
B(-0.9)	1	x	0.8	0.3	0.9	x	-0.4	x	x	x	x	x	x	x	x	x
C(0 9)		1	x	0.6	x	0.9	x	x	x	x	0.4	-0.4	x	x	x	x
D(1.6)			1	0.6	0.8	x	x	x	x	x	0.3	x	0.4	x	x	x
E(1.8)				1	0.4	0.5	x	x	0.6	0.4	0.7	-0.6	0.4	x	0.6	x
F(-1.1)					1	x	x	x	x	x	x	x	x	x	x	x
G(-0.4)						1	x	x	x	x	0.5	-0.3	x	x	x	x
I(0.3)							1	x	x	x	x	x	x	x	x	x
J(0.1)								1	x	x	x	x	x	x	x	x
K(0.0)									1	0.6	0.8	-0.7	0.6	-0.6	0.9	-0.5
L(-0.2)										1	0.5	x	x	-0.3	0.5	x
M(-1.0)											1	-0.8	0.7	-0.5	0.8	x
N(0.4)												1	-0.7	0.7	-0.7	0.4
O(0.7)													1	-0.4	0.6	-0.4
P(-0.4)														1	-0.6	0.5
Q(0.0)															1	-0.6
R(0.1)																1

TABLE 56

Multiple Regression Analysis - Table of Pearson Correlation Coefficients

by Individual Area

Area - 9 (Craigleith Hill Avenue)								Significant Pearson Correlations Over 0.4								
	(-1 1) B	(0.1) C	(1.9) D	(-0.2) E	(-0.3) F	(0.4) G	(0.5) I	(0.0) J	(0.2) K	(0.0) L	(0.1) M	(-0.2) N	(-0.3) O	(-0.4) P	(0.7) Q	(0.4) R
B(-1.1)	1	0.6	0.7	0.4	0.8	x	x	x	x	x	x	x	x	x	x	x
C(0.1)		1	x	x	x	0.7	-0.4	x	x	-0.4	x	x	x	x	x	x
D(1.9)			1	0.6	0.7	x	0.7	x	0.5	x	0.7	-0.6	0.6	x	0.5	-0.3
E(-0.2)				1	0.5	0.4	x	x	0.4	x	0.6	-0.6	0.6	-0.5	0.5	-0.4
F(-0.3)					1	x	x	x	x	x	x	-0.3	x	x	x	x
G(0.4)						1	-0.4	x	x	x	x	x	x	x	x	x
I(0.5)							1	x	0.4	x	0.6	-0.4	0.4	x	0.4	x
J(0.0)								1	0.4	0.6	x	x	0.4	x	0.4	x
K(-0.2)									1	0.5	0.5	-0.6	0.6	-0.8	0.7	x
L(-0.3)										1	0.5	-0.4	0.6	x	0.4	x
M(0.1)											1	-0.8	0.8	-0.4	0.8	-0.4
N(-0.2)												1	-0.8	0.7	-0.7	0.4
O(-0.3)													1	-0.5	0.7	x
P(-0.4)														1	-0.5	0.5
Q(0.7)															1	-0.4
R(0.4)																1

TABLE 57

Multiple Regression Analysis - Table of Pearson Correlation Coefficients

by Individual Area

Area - 10 (Pilton)	Significant Pearson Correlations Over 0.4															
	(-0.4) B	(-0.9) C	(0.5) D	(0.4) E	(-0.2) F	(0.6) G	(0.1) I	(0.1) J	(0.1) K	(-0.7) L	(0.8) M	(0.6) N	(0.0) O	(-0.4) P	(0.7) Q	(0.4) R
B(-0.4)	1	x	0.8	x	0.9	x	x	x	x	0.5	x	x	x	x	x	x
C(-0.9)		1	x	0.4	x	0.7	x	x	x	x	0.3	-0.4	0.4	x	x	x
D(0.5)			1	0.6	0.9	x	x	0.4	0.4	0.4	0.4	x	0.4	x	0.4	x
E(0.4)				1	x	0.5	x	x	0.4	x.	0.6	-0.5	0.6	x	0.5	-0.3
F(-0.2)					1	x	x	x	x	0.5	x	x	x	x	x	x
G(0.6)						1	x	x	x	x	0.4	x	x	x	x	x
I(0.1)							1	0.3	0.3	x	x	-0.4	x	x	0.5	x
J(0.1)								1	0.5	x	0.4	x	x	x	0.5	x
K(0.1)									1	x	0.3	x	x	x	0.8	x
L(-0.7)										1	0.4	x	0.4	x	x	0.4
M(0.8)											1	-0.7	0.8	x	0.4	x
N(0.6)												1	-0.7	0.4	-0.4	x
O(0.0)													1	x	x	x
P(-0.4)														1	x	x
Q(0.7)															1	-0.4
R(0.4)																1

TABLE 58

Multiple Regression Analysis - Table of Pearson Correlation Coefficients

by Individual Area

Area - 11 (Cammo)	Significant Pearson Correlations Over 0.4															
	(-0.8) B	(0.3) C	(0.6) D	(0.1) E	(0.6) F	(-0.3) G	(-0.1) I	(0.6) J	(0.5) K	(-1.3) L	(-0.4) M	(0.2) N	(0.3) O	(-0.7) P	(1.0) Q	(-0.4) R
B(-0.8)	1	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
C(0.3)		1	x	x	x	x	x	x	x	x	x	x	x	x	x	x
D(0.6)			1	0.9	0.5	x	x	0.8	0.7	0.7	0.7	-0.5	x	-0.7	0.8	x
E(0.1)				1	0.4	x	x	0.8	0.7	0.7	0.7	-0.4	x	-0.7	0.7	x
F(0.6)					1	x	x	x	0.5	x	0.5	-0.5	x	-0.6	x	x
G(-0.3)						1	x	x	x	x	x	x	x	x	x	x
I(-0.1)							1	x	x	x	0.4	-0.6	0.6	-0.5	x	x
J(0.6)								1	0.7	0.9	0.7	x	x	-0.5	0.8	x
K(0.5)									1	0.6	0.7	x	x	-0.7	0.7	-0.5
L(-1.3)										1	0.6	x	0.6	-0.5	0.9	x
M(-0.4)											1	-0.8	0.7	-0.8	0.6	x
N(0.2)												1	-0.7	0.8	x	x
O(0.3)													1	-0.5	0.6	x
P(-0.7)														1	-0.6	x
Q(1.0)															1	-0.6
R(0.4)																1

TABLE 59

Multiple Regression Analysis - Table of Pearson Correlation Coefficients

by Individual Area

Area - 12 (Turnhouse)						Significant Pearson Correlations Over 0.4										
	(-1.2) B	(0.5) C	(0.2) D	(0.4) E	(0.2) F	(0.2) G	(0.1) I	(0.1) J	(0.6) K	(-0.1) L	(0.0) M	(0.5) N	(0.7) O	(0.5) P	(0.3) Q	(0.3) R
B(-1.2)	1	0.4	0.7	0.6	0.7	x	x	x	x	x	x	-0.3	x	x	x	x
C(0.5)		1	x	0.6	x	0.7	x	x	x	x	0.4	x	x	x	x	x
D(0.2)			1	0.7	0.8	x	x	0.3	x	x	x	x	x	x	x	x
E(0.4)				1	0.6	0.6	x	x	x	x	0.5	x	0.4	x	x	0.3
F(0.2)					1	x	x	x	x	x	x	x	x	x	x	x
G(0.2)						1.	x	x	0.5	x	0.5	x	x	x	x	x
I(0.1)							1	x	x	x	x	x	x	x	x	x
J(0.1)								1	x	x	x	x	x	-0.4	x	x
K(0.6)									1	x	0.4	x	x	x	0.4	x
L(-0.6)										1	x	x	x	-0.4	0.3	0.4
M(0.0)											1	-0.4	0.7	x	x	0.4
N(0.5)												1	x	0.4	x	-0.4
O(0.7)													1	x	x	x
P(0.5)														1	x	x
Q(0.3)															1	x
R(0.3)																1

TABLE 60

Multiple Regression Analysis - Table of Pearson Correlation Coefficients

by Individual Area

Area - 13 (Leith)	Significant Pearson Correlations Over 0.4															
	(0.1) B	(-0.1) C	(0.6) D	(0.1) E	(-1.4) F	(-1.0) G	(0.1) I	(0.9) J	(-1.2) K	(0.5) L	(-0.1) M	(-0.1) N	(-0.8) O	(-0.8) P	(0.3) Q	(-0.5) R
B(0.1)	1	x	0.6	-0.4	0.8	-0.4	x	x	x	x	x	x	x	0.3	x	0.3
C(-0.1)		1	-0.4	0.7	-0.3	0.9	x	x	x	x	x	x	0.4	x	x	x
D(0.6)			1	x	0.8	-0.3	x	x	x	x	x	x	x	x	x	x
E(0.1)				1	x	0.9	x	x	x	x	0.5	-0.3	0.5	x	0.4	x
F(-1.4)					1	-0.4	x	x	x	-0.5	x	x	x	x	-0.4	0.4
G(-1.0)						1	x	x	x	x	0.4	x	0.5	x	x	x
I(0.1)							1	0.5	0.4	x	x	x	x	x	x	x
J(0.9)								1	0.7	x	x	x	x	x	x	x
K(-1.2)									1	x	0.3	-0.4	x	-0.6	0.5	-0.3
L(0.5)										1	0.3	x	x	x	0.5	x
M(-0.1)											1	-0.8	0.5	-0.4	0.5	x
N(0.1)												1	-0.6	0.6	-0.5	x
O(-0.8)													1	-0.4	0.5	x
P(-0.8)														1	-0.6	0.5
Q(0.3)															1	-0.6
R(-0.5)																1

TABLE 61

Multiple Regression Analysis - Table of Pearson Correlation Coefficients

by Individual Area

Area - 14 (Craigleith Cres./View)								Significant Pearson Correlations Over 0.4								
	(1.1) B	(-0.4) C	(-1.1) D	(-0.3) E	(-0.2) F	(0.1) G	(-0.2) I	(0.3) J	(-0.5) K	(-0.9) L	(0.6) M	(0.5) N	(-0.4) O	(-0.8) P	(-0.1) Q	(-0.2) R
B(1.1)	1	x	0.8	0.4	0.8	x	x	x	x	x	x	x	x	x	x	x
C(-0.4)		1	x	0.5	x	0.8	x	x	x	0.4	x	x	x	x	x	x
D(-1.1)			1	0.6	0.8	x	x	x	x	x	x	x	0.4	x	x	x
E(-0.3)				1	0.5	0.4	x	x	0.5	0.5	0.5	-0.5	0.6	x	x	x
F(-0.2)					1	x	x	x	x	x	x	x	x	x	x	x
G(0.1)						1	x	x	x	0.4	x	x	x	x	x	x
I(-0.2)							1	x	x	x	x	x	x	x	x	x
J(0.3)								1	x	0.6	0.5	-0.4	0.5	-0.6	0.6	x
K(-0.5)									1	0.6	0.6	-0.6	0.6	-0.7	0.6	-0.4
L(-0.9)										1	0.7	-0.6	0.6	-0.6	0.5	-0.4
M(0.6)											1	-0.9	0.8	-0.6	0.5	-0.3
N(0.5)												1	-0.8	0.7	-0.6	x
O(-0.4)													1	-0.5	0.5	-0.3
P(-0.8)														1	-0.8	0.4
Q(-0.1)															1	-0.6
R(-0.2)																1

TABLE 62

Multiple Regression Analysis - Table of Pearson Correlation Coefficients

by Individual Area

Area - 15 (Easter Rd./Dalry Rd.)								Significant Pearson Correlations Over 0.4								
	(-0.3) B	(0.0) C	(0.4) D	(-0.9) E	(0.1) F	(-0.4) G	(-0.1) I	(-0.3) J	(0.1) K	(0.1) L	(-0.4) M	(0.7) N	(-0.7) O	(0.2) P	(0.9) Q	(0.0) R
B(-0.3)	1	x	0.6	x	0.6	-0.3	0.4	x	x	x	x	x	x	x	x	x
C(0.0)		1	x	0.6	x	0.8	x	x	x	x	0.6	-0.4	0.6	-0.6	x	x
D(0.4)			1	0.5	0.6	x	x	x	x	x	x	x	x	x	x	x
E(-0.9)				1	x	0.6	x	x	0.5	x	0.8	-0.4	-0.5	x	x	x
F(0.1)					1	x	x	x	x	x	x	x	x	x	x	x
G(-0.4)						1	x	x	0.4	x	0.7	-0.5	0.7	-0.6	x	x
I(-0.1)							1	x	x	x	x	0.3	x	0.4	x	x
J(-0.3)								1	x	x	x	x	x	x	0.5	x
K(0.1)									1	x	0.6	-0.6	0.6	-0.6	0.5	x
L(0.1)										1	x	x	x	x	x	x
M(-0.4)											1	-0.5	0.8	-0.6	0.4	x
N(0.7)												1	-0.5	0.7	-0.7	0.5
O(-0.7)													1	-0.7	0.6	x
P(0.2)														1	-0.6	0.4
Q(0.9)															1	-0.6
R(0.0)																1

TABLE 63

Multiple Regression Analysis - Table of Pearson Correlation Coefficients

by Individual Area

Area - 16 (Total)	Significant Pearson Correlations Over 0.4															
	(-0.3) B	(-0.1) C	(0.5) D	(0.8) E	(-0.1) F	(0.1) G	(0.1) I	(0.0) J	(0.4) K	(0.0) L	(0.6) M	(0.0) N	(0.0) O	(0.1) P	(0.3) Q	(0.1) R
B(-0.3)	1	x	0.7	x	0.8	x	x	x	x	x	x	x	x	x	x	x
C(-0.1)		1	x	0.4	x	0.7	x	x	x	x	x	x	x	x	x	x
D(-0.5)			1	0.6	0.8	x	x	x	0.4	x	x	x	x	x	x	x
E(0.8)				1	x	0.5	x	x	0.4	x	0.6	-0.4	-0.4	x	x	x
F(-0.1)					1	x	x	x	x	x	x	x	x	x	x	x
G(0.1)						1	x	x	x	x	x	x	x	x	x	x
I(0.1)							1	x	0.4	x	x	x	x	x	x	x
J(0.0)								1	0.5	0.5	x	x	x	x	x	x
K(0.4)									1	0.5	0.4	-0.4	0.4	-0.6	0.5	x
L(0.0)										1	0.4	x	0.4	-0.4	0.4	x
M(0.6)											1	-0.6	0.7	x	0.5	x
N(0.0)												1	-0.6	0.6	-0.5	x
O(0.0)													1	x	0.4	x
P(0.1)														1	-0.5	x
Q(0.3)															1	-0.4
R(0.1)																1

TABLE 64

Multiple Regression Analysis - Table of Pearson Correlation Coefficients

by Individual Area

based on the shopping expenditure variables. This is generally true, and it is suppported by the canonical correlation analysis, in that the presence of a strong relationship between dependent and independent variables has its basis in the expenditure variables D and E.

The correlations within the dependent and independent variables are generally strong and will tend to reduce the correlation between dependent and independent variables. The number of variables also influences the correlation coefficient and this is adjusted to yield a more conservative estimate. The method of adjustment is based on the formula :

r^2 in the population

$$= \frac{\text{error variance in Y in the population}}{\text{total variance in Y in the population}}$$

The adjusted r^2 formula uses unbiased estimates of the error variance and the total variance in the population. The formula used in the SPSS computer package is :

$$\text{Adjusted } r^2 = r^2 - \left(\frac{k-1}{N-k} \right) (1 - r^2)$$

where k = number of independent variables in the regression equation.

N = number of cases.

In Appendix H the adjusted r^2 values have not been written into the standard output since the individual area model shows a low predictive capability.

7.8.4 Examination of Residuals

These comments on the examination of the residuals apply to the preceding multiple regression analysis and to the subsequent multiple regression analysis. The residuals list for each output was checked for any regular pattern of positive and negative runs. They were also checked for any regular pattern of scatter about the mean and their randomness was checked using the Durban-Watson test statistic and the plotting of the residual values on probability paper to confirm their linearity. These checks confirm that no abnormality exists in the residuals.

7.8.5 Multiple Regression Analysis with respect to the Total Data Matrix

It is not expected that a predictive model, using Model 2 and the total data matrix, will provide a satisfactory prediction capability. The overall canonical correlation coefficient is low and inspection of Table 64 shows that only income (K) is correlated, at a low level of 0.4, with store expenditure (D), with the duration and frequency variables uncorrelated at, or above, the 0.4 level. This is confirmed by inspection of Table 65 and Appendix I-16 where the r^2 values of frequency (F), duration of stay (B) and expenditure (D) were 8%, 4% and 18% respectively. If the analysis is carried out for the total shopping expenditure (E) the equation explains 38% of the variance in the dependent variable. The interest in the difference between bulk-buying expenditure (D) and total shopping expenditure (E) relates to the elimination of the zero expenditure values found in D. The presence and effect of zero values in general is discussed in the next chapter on the interpretation of the analysis. The results of the multiple regression analysis based on total shopping expenditure are shown in Table 66 and Appendix J.

A further analysis was carried out using a relative household expenditure term, T, defined as the total shopping budget (E) minus the bulk-buying budget (D).

FILE F1 (CREATION DATE = 06/03/83)

* M U L T I P L E   R E G R E S S I O N * * * * * * * * * * * * * *   VARIABLE LIST 1
REGRESSION LIST 1

DEPENDENT VARIABLE.. F

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
K	0.17541	0.03077	0.03077	0.17541	0.75624[illegible]E-01	0.194[illegible]
Q	0.21850	0.04774	0.01697	-0.01957	-0.136413[illegible]E-01	-0.21[illegible]
N	0.26990	0.07285	0.02510	-0.16357	-0.55647[illegible]1E-02	-0.193[illegible]
M	0.27784	0.07719	0.00435	0.14455	0.350861[illegible]E-01	0.08635
R	0.28142	0.07920	0.00200	0.04409	0.478476[illegible]E-0[illegible]	0.042[illegible]5
I	0.28329	0.08025	0.00105	0.09562	0.352517[illegible]E-01	0.03322
J	0.28467	0.08104	0.00079	0.10063	0.5402227E-01	0.0385[illegible]
P	0.28559	0.08156	0.00053	-0.11316	0.3635347E-02	[illegible].034[illegible]
O	0.28616	0.08189	0.00032	0.11620	-0.1761946E-02	-0.0267[illegible]
(CONSTANT)					0.7254079	

TABLE 65

Multiple Regression Analysis F with I to R; F with B, D; B with I to R; and D with I to R for Total Data Matrix

FILE F1 (CREATION DATE = 06/03/83)

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * * * VARIABLE LIST 1
REGRESSION LIST 2

DEPENDENT VARIABLE.. F

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	ETA
B	0.78158	0.61086	0.61086	0.78158	0.3894268	0.49810
D	0.84184	0.70870	0.09783	0.75616	0.1663123E-01	0.42166
(CONSTANT)					0.1039273	

TABLE 65 (Contd.)

Multiple Regression Analysis F with I to R; F with B, D; B with I to R; and D with I to R for Total Data Matrix

FILE F1 (CREATION DATE = 06/03/83)

* MULTIPLE REGRESSION * * * * * * * * * * * * * * VARIABLE LIST 1
REGRESSION LIST 1

DEPENDENT VARIABLE..

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
N	0.09420	0.00887	[illegible]	[illegible]	[illegible]	[illegible]
G	0.16045	0.02574	0.01687	-0.07343	[illegible]	[illegible]
Y	0.17987	0.03235	0.00661	[illegible]	[illegible]	[illegible]
I	0.18811	0.03538	[illegible]	[illegible]	[illegible]	[illegible]
M	0.19408	0.03767	0.00228	0.07459	[illegible]	[illegible]
R	0.19741	0.03897	0.00130	[illegible]	0.5662411E-02	0.03523
O	0.19901	0.03960	0.00063	0.04826	[illegible]	[illegible]
J	0.19955	0.03982	0.00022	0.02577	[illegible]	0.01574
L	0.19978	0.03991	[illegible]	[illegible]	[illegible]	[illegible]
P	0.19990	0.03996	0.00005	-0.04316	[illegible]	0.01667
(CONSTANT)					[illegible]	

TABLE 65 (Contd.)

Multiple Regression Analysis F with I to R; F with B, D; B with I to R; and D with I to R for Total Data Matrix

FILE F1 (CREATION DATE = 06/03/83)

* M U L T I P L E   R E G R E S S I O N * * * * * * * * * * * * * * VARIABLE LIST 1
REGRESSION LIST 4

DEPENDENT VARIABLE.. G

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
K	0.35550	0.12638	0.12638	0.35550	2.1[illegible]	0.22[illegible]13
M	0.41082	0.16878	0.04240	0.33042	1.4[illegible]5230	0.13[illegible]
I	0.41893	0.17550	0.00673	0.21311	2.644112	0.08925
N	0.42742	0.18269	0.00719	-0.09628	-0.1623825	-0.14993
R	0.43505	0.18927	0.00658	-0.01767	0.1724851	0.06604
P	0.43933	0.19361	0.00374	-0.22106	0.2726430	0.10347
L	0.44266	0.19595	0.00294	0.26649	1.211308	0.05656
J	0.44399	0.19713	0.00118	0.23147	1.611811	0.045[illegible]
O	0.44445	0.19753	0.00041	0.26564	-0.5018324E-01	-0.03005
(CONSTANT)					6.210965	

TABLE 65 (Contd.)

Multiple Regression Analysis F with I to R; F with B, D; B with I to R; and D with I to R for Total Data Matrix

FILE F1 (CREATION DATE = 10/17/83)

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * VARIABLE LIST 1
REGRESSION LIST 1

DEPENDENT VARIABLE.. E

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
M	0.57308	0.32842	0.32842	0.57308	5.171842	0.44962
K	0.60402	0.36484	0.03641	0.40321	1.935037	0.19061
G	0.61138	0.37379	0.00895	0.42162	0.2611621	0.15749
R	0.61293	0.37568	0.00190	-0.09279	0.1704648	0.05768
L	0.61450	0.37761	0.00193	0.27742	-1.214419	-0.05439
P	0.61505	0.37829	0.00068	-0.27827	0.1094700	0.03996
I	0.61542	0.37875	0.00046	0.17657	0.7491254	0.02407
N	0.61549	0.37883	0.00008	-0.37801	-0.1163741E-01	-0.01379
(CONSTANT)					5.933363	

TABLE 66

Multiple Regression Analysis - E with I to R for the Total Data Matrix

This was done to equalise the proportion of total shopping budget spent at large foodstores. However, the results of the analysis showed that only 12% of the variance in T was predicted by the independent variables. The results of the analysis are shown in Appendix K.

7.8.6 Multiple Regression Analysis with respect to the Means Data Matrix, with and without the Spatial Accessibility Index

The means data matrix has been shown to form the basis of a predictive model at mean area level. It is expected that the development of a model based on multiple regression analysis will support this view. The analysis was carried out in three stages :

i) with all the independent variables
ii) with income (K) and freezer ownership (I) omitted
iii) with personal accessibility (R), income (K) and freezer ownership (I) omitted.

The reason for this is that the three variables mentioned in stages (ii) and (iii) are not contained within census data and as part of the research objectives require a strategic model based on census data these have been removed to see if their omission impairs the model significantly. The results of the analysis are shown in Appendix L. The adjusted r^2 values have been added to the output listing.

Omitting all three variables the highest adjusted multiple correlation coefficients, which are significant at the 5% level are:

Frequency of visit (F) = 0.75 (adjusted r^2 = 43%)
Duration of stay (B) = 0.71 (adjusted r^2 = 37%)
Expenditure per visit (D) = 0.80 (adjusted r^2 = 50%)

If personal accessibility (R) is included the values become :

Frequency of visit (F) = 0.92 (adjusted r^2 = 65%)
Duration of stay (B) = 0.96 (adjusted r^2 = 86%)
Expenditure per visit (D) = 0.87 (adjusted r^2 = 62%)

The values with all independent variables included are :

Frequency of visit (F) = 0.98 (adjusted r^2 = 83%)
Duration of stay (B) = 0.97 (adjusted r^2 = 85%)
Expenditure per visit (D) = 0.96 (adjusted r^2 = 77%)

These figures show a good prediction of the three individual dependent variables. The store expenditure variable requires income (K) and freezer ownership (I) to be included to achieve a level of 77% prediction. The duration of stay variable (B), important for car parking capacity, requires the addition of personal accessibility (R), raising the level of variance in B explained from 37% to 86%. The frequency of visit variable (F), important for trip prediction, requires all the independent variables to achieve an 83% prediction. Thus each of the store dependent variables can be predicted using household characteristics. The application and stability of these multiple regression equations will be discussed in the following chapter. Note that spatial accessibility (S) becomes the most important variable for frequency of use when personal accessibility (R) and income (K) are removed.

7.8.7 Multiple Regression Analysis with Respect to Model 1

The results of the analysis relating to Model 1 have supported the conceptual theory of three independent factors of influence on two store usage factors. However the model based on this structure has shown no stability between areas and the analysis has indicated that the predictive capability of a factor-based model will be poor. To investigate this further the multiple regression analysis was carried out in four stages :

i) to define the usage index as a linear combination of all six dependent variables and to correlate this with the individual dependent variables by area.

ii) to define the usage index as a linear combination of the three store usage variables relating this to the principal components structure, using weighted and unweighted variables, for the total data matrix. This will test the effect of the component weightings on the multiple regression coefficient.

iii) as in (ii) but applied at individual area level.

iv) as in (ii) but applied to the means data matrix.

The results of stage (i) of the analysis are shown in Appendix M. In seven areas the grouped usage index had a lower correlation coefficient than the Model 2 structure. In the remaining eight areas the coefficients were of the same order of magnitude. There is therefore no advantage in this form of model. This is further exacerbated by measurement difficulties associated with the usage index. As with the preceding stages of the analysis there is no uniform variable structure between areas.

The second stage of the analysis applied to the total data matrix using the weighted and unweighted principal components structure. The results of the analysis are shown in Appendix N. Although the coefficient is greater than for the individual usage variables it is very low at 0.36 unweighted and 0.37 weighted. Thus only 12% and 13%

of the variance in the usage index is predicted with the component weighting making no appreciable difference to the prediction.

The third stage of the analysis related to the individual areas using the model of stage (ii). The analysis was carried out using the total data matrix component weightings and with area component weightings. This was applied to only the first seven areas as it was not expected to yield high prediction levels. The results are shown in Appendix O. These results show the same pattern as stages (i) and (ii) in that the correlation coefficient in all seven areas is lower than other forms of model and the component weightings make no significant difference to the prediction.

The final stage of this section of the analysis relates to the means data matrix, with and without spatial accessibility. The results of the analysis are shown in Appendix P. The model does not perform as well as the individual usage variables of Model 2 and the addition of the spatial accessibility variable marginally decreases the value of the multiple correlation coefficient. In keeping with the results from the principal components analysis and the canonical correlation analysis Model 1 does not provide a basis for a trip generation model of private-car trips to large foodstores.

7.8.8 The multiple regression analysis examined the predictive capabilities of the two proposed models. Model 2, based on individual variables, showed the same areal instability as the previous stages of the analysis and, with the exception of store expenditure, did not provide high levels of prediction for the store usage variables. As the areal canonical correlation between the dependent and independent variables is consistently high this indicates that to achieve this relationship all the store variables are required. Thus when separated the relationships, as seen by the Pearson correlation matrices, are not strong enough to produce high multiple correlations. The model based on the total data matrix explained 40% of the variance in the dependent variables.

This is a creditable performance when one considers that the model is attempting to predict the store usage of each household but is not satisfactory with respect to a trip prediction model for development control. As with the other sections of the analysis the means data matrix provided a basis for good prediction of the three dependent store variables. The structure and stability of these equations will be discussed in the following chapter.

The analysis based on Model 1, using the principal components structure, did not provide any advantage over Model 2 and in most cases yielded lower prediction levels. It is proposed therefore to develop the disaggregate trip generation model on Model 2 using the means data matrix. This is complementary to current transport modelling techniques based on transport zones, the difference being these equations are based at a more disaggregate level and have been developed from the household characteristics of an area. These characteristics are largely census based and can adapt to the changing land-use patterns of an area without recourse to further major household surveys.

7.9 Concluding Remarks

The analysis of the data has been carried out in three sections : the production of the Pearson correlation matrices and the principal components analysis to establish the form of Model 1, the canonical correlation analysis to establish the strength and structure of the relationship between the dependent and independent variables and the multiple regression analysis to develop the predictive model.

The principal components analysis identified a stable data structure at an aggregated level but did not find that this structure was maintained at area level. The canonical correlation analysis established that a strong relationship existed between the two variable sets at area level but that this relationship required all the dependent variables to be present. As the areas were aggregated the canonical relationship diminished, in other words the independent variables were defining store usage with respect to the character of the area and as areas were added together these strong relationships were cancelling each other out because of the areal variation in bivariate relationships. Thus as areas were added the canonical coefficient declined in proportion to the area sample size.

The area means data smoothed out the areal variation and enabled strong relationships to be established between the individual dependent variables and the independent variables. This was developed in the multiple regression analysis to provide three equations, for the three store variables, with an 80%-90% level of prediction. This model cannot be improved upon at individual area or total data matrix level or by using the principal components structure.

The development and application of this model will be considered in the following chapter.

CHAPTER 8

INTERPRETATION AND DISCUSSION OF THE FINDINGS

8.1 Introduction

This chapter gives an overview of the analysis and interprets the results with respect to the research objectives. The interpretation specifically addresses the problem of within and between area variations. The interpretation is then discussed with specific reference to the areal variation, level of disaggregation achieved and stability of the model. The chapter concludes with a discussion of the application of the three proposed sub-models and their interface with the distribution model. The development and application of the combined model to development control procedures is also discussed.

8.2 An Overview of the Analysis

8.2.1 The conceptual framework of the thesis postulated that private-car trips to large foodstores could be split into two parts comprising the generation of trips and the distribution of trips to the stores in the study area. The research objectives sought to identify this disaggregate generation model, find the level of disaggregation able to satisfy the prediction accuracy required and explain the model's interaction with an aggregate distribution model. The generation model could not be defined a priori and two conceptual models were proposed. These models were based on the belief that the choice mechanism of the consumer could be modelled from observed behaviour which in turn could be related to national census data on each household.

8.2.2 The inspection of the Pearson bivariate correlation matrix confirmed that the six dependent, shopping variables were inter-related and many of the independent variables were inter-related especially, as expected, the three household structure variables and income, employment and SEG. The inter-relationships between the dependent and independent variables were based on the two shopping expenditure variables, D and E. The areal variation, which has been mentioned at each stage of the analysis, could be seen at this preliminary stage where area 1 (Moredun) and area 12 (Turnhouse) showed significant variation in the strength of the bivariate correlations.

8.2.3 The principal components analysis examined model 1, based on five composite variable factors. The analysis sought to confirm this model structure so that a store usage index could be identified. However, although the aggregated data supported the conceptual structure the model broke down at individual area level. The model based on the aggregated data explained 80% of the variation within the dependent variables and 64% within the independent variables. The structure based on the means data matrix explained 100% of the variation within the dependent variables and 85% within the independent variables. The addition of a spatial accessibility index did not add to the level of explanation significantly. The above figures highlight the smoothing effect of the means data matrix, which shall be discussed in detail later in the chapter.

8.2.4 The canonical correlation analysis sought to establish the strength and structure of the relationship between the dependent and independent variables. The analysis showed that in all areas the strength of relationship was high, around 80% explanation, but when the areas were aggregated the correlation coefficient fell to 0.64, 41% explanation, for the total data matrix. This supported the conclusion of the principal components analysis in that each area achieved the strong canonical correlation using a different model structure. The canonical correlation declined in proportion to a rising sample size. This means that as the within-area variation increases the percentage variance explained decreases.

8.2.5 The 0.64 coefficient was achieved using all the dependent variables and all the independent variables. If the three store variables were used with all the independent variables the coefficient fell to 0.53, however if only three of the independent variables were used the coefficient only fell by 0.02 to 0.51. The three independent variables were chosen relative to the canonical-weightings for each area and therefore differed from area to area.

8.2.6 The multiple regression analysis showed that a general model could be achieved using the means data matrix but because of the areal variation a general model could not be applied within each area at household level. As a consequence of this areal variation the total data matrix did not provide a strong predictive model. The means data matrix, without income (K), freezer ownership (I) and personal accessibility (R), attained multiple correlation coefficients of 0.75, 0.69 and 0.80 for frequency of visit (F), duration of stay (B) and expenditure per visit (D) respectively but the adjusted r^2 values fell to 0.43, 0.39 and 0.50. The addition of personal accessibility (R) raised the adjusted values to 0.65, 0.86 and 0.62 and the further addition of income (K) and freezer ownership (I) raised the values to 0.83, 0.79 and 0.77.

8.3 Interpretation of the results

8.3.1 The canonical correlation showed that the postulated theory, that a relationship exists between shopping usage and household characteristics, is correct. It further showed that the relationship is strong, with an 80% explanation of the dependent variables. However the way in which this explanation is achieved varies from area to area. Tables 49 to 64 show the Pearson bivariate correlations by area. It can be clearly seen, by inspection of the upper-right quartile, that the prediction of store usage depends on the shopping expenditure variables and their relationship to the independent variables. These tables show the areal variation and why certain areas, such as area 1 (Moredun), do not produce a good relationship between the two sets of variables. They do not explain, however, why this areal variation exists.

8.3.2 A low correlation between a variable pair can be attributed to one of three reasons :

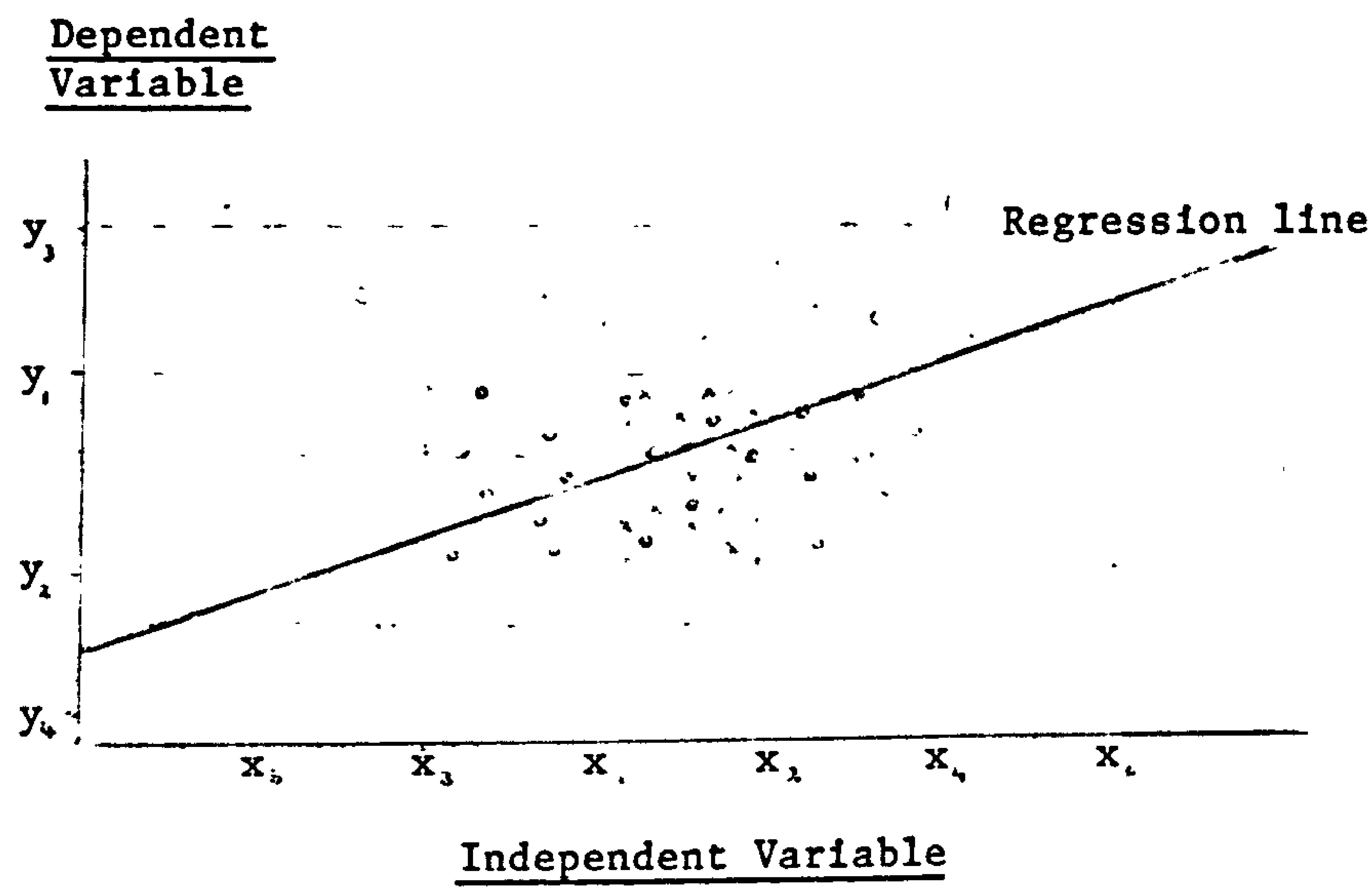
a) there is no relationship
b) the variable variance is low

c) the relationship is not linear.

The third reason can be discounted as this was investigated, using scatter diagrams, in the initial stages of the analysis. The first two reasons require further discussion.

Table 10 shows the standard deviations for the two sets of variables. If two extreme areas, i.e. an area which gives a poor relationship and an area which gives good relationship between the two variable sets, such as area 1 (Moredun) and area 11 (Cammo), are inspected the standard deviation of key independent variables income (K), number in the household (M), mean age of household (N) and employment (Q) show a consistently lower value in area 1 than in area 11. This lack of dispersion is also evident in area 12 (Turnhouse), another area which has consistently shown a poor predictive quality. This lack of variance can be explained by the characterisitics of these areas. For example, in area 1 there is a high proportion of retired couples whose income level will be relatively uniform, given the quality of the area. Therefore although it is an area of private housing the store usage level is low due to the low demand of this group and the lack of large store facilities within walking distance of the area.

8.3.3 The general situation is shown graphically in the sketch below. In certain areas the values of the independent variable are clustered between a narrow band on the x-axis (between x_1 and x_2). This affects the ability of the regression model to predict an accurate relationship. If there is a larger variation in the independent variable then there is a greater spread, and hence the standard deviation of the variable is increased. If this is achieved within a sample of equivalent size then the regression correlation coefficient of that sample will compare favourable with the former (between x_3 and x_4). If, however, to achieve the increased standard deviation the sample size is increased then there will be the negative effect of increased spread in the y-axis due to the normally expected variation between households (from y_1, y_2 to y_3, y_4).

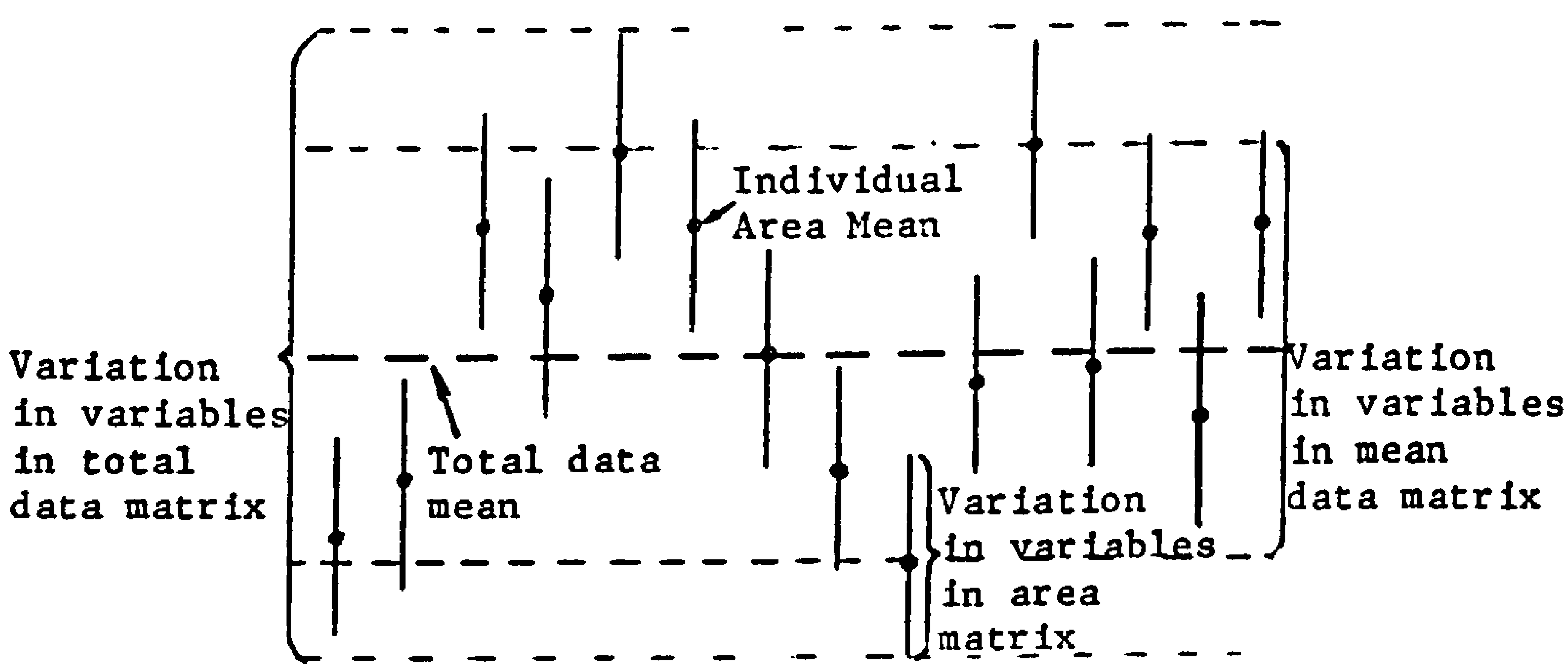


Key :

x Values with small standard deviation within x_1, x_2
. Equivalent size of sample but with larger deviation within x_3, x_4
o Increased sample within x_5, x_6.

8.3.4 This problem is not related to an optimisation of sample, or zone size, but rather a symptom of the variation between households and between the areas of households. The variation, in this case, is the variation in the standard deviation of a particular variable from area to area. The implication of this is that the developed trip generation model should be applied at the most disaggregate level at which household census data can be extracted i.e. at the ennumeration district level. as these areas are aggregated then the least-squares difference will increase because of the increased spread around the regression line and the correlation coefficient will fall.

8.3.5 Thus the smallest practical zone size is the ennumeration district, approximately 120 households. An analysis at this level would use the variable means within each district. The means data matrix giving a consistently accurate prediction capability. This is not to imply that the overall accuracy of the model has increased but that by taking the variable means values within each area the areal variability has been reduced. This will yield a zonal base, rather than a household base, which is required for the trip distribution model at a later stage. The variation within and between areas is explained in the sketch below.



The diagram represents the areal variation and the larger variation in the total data matrix. When the means of area variables are taken the overall variation is much less but the variance between means is sufficient to yield a high predictive correlation.

8.3.6 From the foregoing it is clear that a predictive model can be based on the means data matrix. However the stability of the variable order, as areas are removed one-by-one from the means data matrix, is subject to fluctuations. The strengths of the F-test values for each stage of the step-wise regression analysis were inspected to identify a reduced number of variables which could predict the store usage variables to an acceptable level and which would remain stable as areas were subtracted. This identified the following groupings :

Frequency of use (F) = Income (K), Mean age of household (N), Number of Licences (L), Personal accessibility (R).

Expenditure per Visit (D) = Income (K), Mean age of household (N), Number of licenses (L), Number in the household (M), Personal accessibility (R).

Duration of Stay (B) = SEG (P), Standard deviation of household ages (O), spatial accessibility (S), personal accessibility (R).

These groupings were stable as each area was subtracted from the means data matrix and the adjusted r^2 values for F, D and B are 72%, 70% and 42% respectively. It should be noted that, as indicated in the previous chapter, the adjusted r^2 takes account of the number of variables and the sample size and the reduced values shown above reflect the small sample size. The unadjusted r^2 values for F, D and B are 80%, 80% and 58%. Higher levels of prediction can be achieved but the variable structure is not stable as areas are removed.

8.3.7 The variables included, however, require justification and an analysis was carried out removing variables one-by-one from each equation to examine the effect on the multiple regression correlation coefficient. The results are as follows:

For frequency of use :

1.a) $F = 1.000 + 0.346K - 0.027N + 0.119R - 1.117L$
$r^2 = 80\%$; adjusted $r^2 = 72\%$

b) $F = 0.573 + 0.043K - 0.015N + 0.061R$
$r^2 = 59\%$; adjusted $r^2 = 48\%$

c) $F = 0.875 + 0.119K - 0.010N$
$r^2 = 47\%$; adjusted $r^2 = 38\%$

d) $F = 0.416 + 0.131K$
$r^2 = 32\%$; adjusted $r^2 = 27\%$

For expenditure at store :

2.a) $D = 13.121 - 15.315L - 0.459N + 6.055K + 1.821R + 2.272M$
$r^2 = 80\%$; adjusted $r^2 = 70\%$

b) $D = 21.222 - 14.758L - 0.504N + 6.170K + 1.768R$
$r^2 = 76\%$; adjusted $r^2 = 66\%$

c) $D = 22.668 - 3.269L - 0.290N + 4.510K$
$r^2 = 65\%$; adjusted $r^2 = 55\%$

d) $D = 17.042 - 8.698L - 0.221N$
$r^2 = 57\%$; adjusted $r^2 = 50\%$

For duration of stay at the store :

3.a) $B = 0.810 - 0.026P + 0.001S + 0.027R + 0.0050$
$r^2 = 58\%$; adjusted $r^2 = 42\%$

b) $B = 0.834 - 0.027P + 0.001S + 0.029R$
$r^2 = 58\%$; adjusted $r^2 = 46\%$

c) $B = 1.251 - 0.033P + 0.002S$
$r^2 = 48\%$; adjusted $r^2 = 39\%$

d) $B = 1.416 - 0.040P$

$$r^2 = 34\%; \text{ adjusted } r^2 = 29\%$$

8.3.8 From the above the three equations which yield the highest levels of prediction of the independent variables and are stable are as follows:

$$F = 1.0 + 0.346K - 0.027N + 0.119R - 1.117L$$
$$B = 0.81 - 0.026P + 0.001S + 0.027R$$
$$D = 13.1 - 15.315L - 0.459N + 6.055K + 1.821R + 2.272M$$

where

F = Frequency of visit to store/week/household
B = Duration of stay at store/week/household
D = Expenditure at store(s)/week/household
K = Income/household
L = Number of licenses in the household
M = Number in the household
N = Mean age of the household
P = SEG of head of household
R = Personal accessibility of principal shopper
S = Spatial accessibility of household.

These are the variables and coefficients of major predictive importance relative to the usage of large foodstores. This means that as household income and personal accessibility rise the frequency of use of the store increases and as the mean age drops frequency of use increases. The latter relationship indicates the presence of children in a household and the increased food demand of a family with young children and teenagers. The inverse relationship between the number of licenses and frequency of use relates to two factors. It is evident, from the experience of working with the data, that households with a high number of licenses tend to be low-income, large families with several people working in low SEG employment. This is supported by the Pearson number in the household rises and SEG falls the number of licenses increases. In addition there is no correlation between the personal accessibility of the shopper and the number of licenses. This was discussed in the previous chapter on accessibility when it was seen that the household reallocates the availability of the household car, or cars, to carry out a major shopping. Thus it is expected that as the number of licenses in the household is associated with households whose frequency of use will be lower, the relationship with frequency of use will be inversely proportional.

The expenditure at the store rises with income, family size and personal accessibility. The negative correlation with the number of licenses has been discussed above. As the mean age of the household falls expenditure rises. The strong positive relationship between the number in the household and the mean age of the household supports the conclusion that larger families have a greater food demand and will generally spend more, all other things being equal.

For the duration of stay equation the time spent at the store rises as the accessibility of the store and shopper rises and as the SEG of the household rises. There is a positive correlation between SEG and personal accessibility but a negative correlation between expenditure at the store and SEG. Thus although households with a lower income and frequency use of the store shop longer, they spend less. It is expected that if frequency of use declines duration of stay will increase. This can be accompanied by increased expenditure if the household budget is high but in this case indicates more careful budgeting of scarce resources.

The increase in the adjusted r^2 when the standard deviation of household ages (O) is omitted, and the fact that the unadjusted r^2 does not decrease, indicates that this variable does not significantly contribute to the model and should not be included.

8.3.9 If these models are applied to the fifteen means data profiles the prediction of the three store usage variables is high. Table 67 lists the results of the analysis. These results per household must be multiplied by the number of households in the ennumeration district to predict the weekly number of trips, duration of stay and expenditure emanating from the area to large foodstores.

8.4 Discussion of the Results

8.4.1 The research objectives seek to identify a disaggregate trip generation model that can be combined with an aggregate distribution model to provide a strategic model for the development control of large foodstores based on the household characteristics of an area. The application of this model will be eased if these characteristics are based on census data, thereby eliminating the need for expensive shopping surveys. The level of disaggregation possible with respect to the model was also to be investigated. At best this would accurately model each household, however this extreme level of disaggregation did not prove satisfactory due to the variation between areas and households. The model developed does however achieve a level of disaggregation acceptable within the objectives of the thesis by basing the model at ennumeration district level, which is the most disaggregate level for census date information.

8.4.2 It was the postulation of the thesis that the choice mechanism of bulk-purchase shopping could be split into a generation stage, where the household characteristics determine the necessity to use these stores, and the distribution stage, where the household decides where to

Area No.	Actual Usage Values: Frequency of use (F) (trip)	Duration of stay (B) (hrs)	Expenditure/ Visit (O) (£)	Predicted Usage Values: Frequency of use (F) (trip)	Duration of stay (B) (hrs)	Expenditure/ Visit (D) (£)
1	0.7	0.9	17.9	0.7	0.9	17.7
2	0.6	0.9	17.0	0.8	0.9	17.3
3	0.7	1.0	15.7	0.6	0.9	13.5
4	0.9	1.1	21.0	0.9	1.1	22.7
5	0.7	0.9	13.9	0.6	0.8	13.6
6	1.1	1.0	28.2	1.0	0.9	24.2
7	0.8	0.9	20.8	0.9	0.9	20.8
8	0.9	1.0	21.6	0.8	0.9	20.3
9	0.7	0.9	18.7	0.8	0.9	19.9
10	0.6	0.8	18.5	0.6	0.8	17.6
11	1.1	1.1	26.3	1.0	1.1	26.1
12	1.1	1.3	28.1	1.1	1.1	26.1
13	0.8	1.1	16.7	0.8	0.9	20.8
14	1.0	1.1	25.8	1.1	1.0	25.4
15	1.1	1.2	20.1	1.1	0.9	23.4

TABLE 67

The Prediction of Frequency of Use, Duration of Stay and Expenditure at Large Foodstores in the Survey Areas Using the Developed Trip Generation Model

shop. The analysis supports this postulation and the final trip frequency model does not contain the spatial accessibility variable. It is included in the duration of stay model as there is a relationship between the distance between a household and a store and the time spent at the store.

8.4.3 Having split the choice process into two parts it was necessary to find the strength and structure of the relationship between the two sets of variables. The canonical correlation showed that all six dependent variables were necessary to obtain areal canonical coefficients of around 0.9 but the structure was not stable between areas. Two levels of variable variation exist; the within-area variation between households and the between-area variation. Neither of the two models postulated could predict the aggregated effect of the two levels of variation at household level but if the means of the variables were taken for each area a model, based on Model 2, could be developed satisfactorily. This model has the advantage over Model 1 in that it separates frequency of trips, duration of stay and expenditure per visit into three multiple regression models.

8.4.4 The issue of accuracy of representation of the sample size requires discussion. Finance dictated a sample size of four hundred households and the sampling framework was designed around this constraint. The fifteen areas were randomly chosen and provide a well-distributed coverage of the city. It must therefore be assumed that if another fifteen areas were randomly chosen the same relationships would be found. Although competition was kept constant, the effect of competing stores on the trip generation of households was found to be insignificant. This may not be true in an area with no large store if a store was then introduced and these results must be taken in the context of an accessible, existing bulk-buying trading pattern.

The proven value of the developed model is in building an accurate mathematical representation of an existing area, which can be updated as census data is updated, thereby providing a base against which the effect of a new store can be measured.

8.4.5 One of the reasons for the inability of either proposed model to cope with the areal variations at household level is the presence of car-owning households who never bulk-buy. The tables of raw data, Appendix E, show that the worst cases are area 10 (Pilton), where 37% of households do not bulk-buy, area 3 (Clermiston), with 29%, and area 1 (Moredun), with 32%. The multiple regression models do not anticipate zero usage and therefore the correlation coefficient is reduced. However a comparison of the store variables and the total shopping variables, which contain no zero values, show that the presence of zero values did not make a major impact on the results of the analysis. The zero values must be included otherwise the sample would be biased and the means data matrix overcomes their presence by smoothing out the variation. The effect is an average trip prediction from an area, which is the desired result from the trip generation model. It is recommended that the effect of the zero values be further investigated so that the model prediction within areas may be improved thereby developing a greater understanding of the consumer choice mechanism at household level.

8.4.6 Thus the three multiple regression models developed provide a set of sub-models that address three specific tasks. The estimation of private-car trips to large foodstores, the design of car parking capacity based on duration of stay and the assessment of market potential from the expenditure model. The first two predict the trip rate and duration per week. Further work requires to be carried out to enable arrival rate throughout the week to be estimated. The raw data contains information on time and day of each shopping trip but a further detailed research programme will be required to build a daily, or hourly, sub-model within the proposed set of sub-models. The present trip estimation can be proportioned over the week based on existing flows to stores in the city and the shopping diaries.

8.5 Concluding Remarks on the Development of the Trip Generation Model

8.5.1 This section, following an overview of the analysis of the two conceptual models, has primarily addressed the problems of variance within the model, the level of disaggregation of the model and model stability. These problems have been discussed with respect to the sample size and sampling framework of the thesis. The variance of the sample comprises the within-area variance and the between-area variance. The aggregated effect of the two kinds of variance make it impossible to predict private-car store usage at the individual household level to an acceptable degree of accuracy. This can be achieved within each area using a different model structure but this lack of stability makes it unsuitable for strategic planning.

8.5.2 If however, the areal variation is smoothed, by taking the mean of each variable, a strategic model for all areas can be developed. The areal variation is caused by two effects. Firstly a lack of spread in the major variables in certain areas due to uniformity of population groups. For example, in area 1 (Moredun) the uniformity of income due to the high proportion of retired couples. Secondly the variation due to the randomness of human behaviour. Whenever a model seeks to predict human response an element of human individuality will always be present. Many factors impinge on the lifestyle of a household making it difficult to predict all permutations with respect to strategic control. Indeed the two are, by definition, largely opposites. An example of this, from the survey, was a high-income household with children and good access to large stores who did not use bulk-buying stores because of a particular vegetarian/whole-food philosophy to life.

There are many such cases each differing in detail but causing variation in the model. The effect of these two factors cause the areal variation. A third factor which could cause the same effect is the omission of critical variables. However in each area the canonical correlation coefficient indicated that the independent variables explained around 90% of the variance in the dependent variables thereby indicating that this was not the case.

8.5.3 The level of disaggregation of the model was examined using the area data, total data and means data matrices. As indicated above the total variation within and between areas produced a low multiple regression correlation coefficient for the total data matrix. The areal variation produced a patchy response in the predictive models even though the structure of the models changed to accommodate the variation. The means data matrix however, provided three models that accurately predicted the three store variables of frequency, duration of stay and expenditure. Thus it is possible to produce a predictive model disaggregated to areas of twenty-seven households. The most disaggregate level at which census data can be abstracted is the ennumeration district. This represents an aggregation of the model from groups of twenty-seven households to around one hundred and twenty households. This also gives the zoning base from which all transportation and physical planning zones are aggregated. It is, therefore, unviersal in its application. This does not represent an increase in accuracy from the household level but a practical model base from which a development control model can be built. The result of the aggregation to area means level is an excellent model prediction of shopping trips emanating from the area.

8.5.4 The stability of the three models was achieved using a reduced set of variables based on the F-test of significance. The models are as follows :

Frequency of use of store/
household/
week (F) $= 1.0 + 0.346K - 0.027N + 0.119R - 1.117L$

Duration of stay at store/
household/ week (B) $= 0.81 - 0.026P + 0.001S + 0.027R$

Expenditure at store/
household/
week (D) $= 13.1 - 15.315L - 0.459N + 6.055K + 1.821R + 2.272M$

where

K = income of the household
L = number of licenses in the household
M = number in the household
N = mean age of the household
P = SEG of head of household
R = personal accessibility of principal shopper
S = spatial accessibility of household to stores.

The structure of these models has been discussed earlier in this chapter and they support the postulated theory of the thesis that the bulk-buying shopping behaviour of a car-owning household can be thought of as a two-stage process. Firstly the characteristics of the household determine the decision to use a large foodstore then the household looks at the alternatives available and chooses a store. Thus the process is split into a trip generation stage and a trip distribution stage. The objective of this thesis is to produce the generation model at a disaggregate level, based on household characteristics. The above set of models achieves this objective.

8.5.5 Thus data is abstracted from each enumeration district (ED) in the defined study area for each variable in the equation. The three variables that cannot be abstracted directly from census data are income, personal accessibility and spatial accessibility. The third of these variables is related to the distribution of stores and will be discussed later in the chapter. It is a physical measurement of the distribution of stores relative to each ED. Income has a strong linear relationship with the number of licenses in the household. The correlation coefficient is 0.87 and the adjusted r^2 value is 87%. The predictive equation, from the means data matrix, is :

$$K = -0.44 + 2.55L$$

where K = household income

L = number of driving licenses in the household

Personal accessibility can also be predicted using the inter-correlations of the independent variables but it requires four variables to achieve an adjusted r^2 figure of 0.68. The step-wise regression output is listed in Table 68. These four variables are stable as areas are subtracted from the means data matrix, except that employment (Q) and the number in the household (N) exchange places after two areas are withdrawn. Further work requires to be done to achieve a better understanding of personal accessibility.

8.5.6 The output from these three models is a trip rate, a duration of stay and an expenditure per household per week at bulk-buying foodstores respectively. These rates are then multiplied by the number of households in the ED to get the total for each ED in the study area. The total number of private-car trips within the study area would then be used to calibrate the trip distribution model, constrained by the pattern of arrivals at the existing stores. Thus a strategic model is developed which can be updated from census data and onto which any new store proposal can be mapped to examine its effect. This concept will now be discussed in greater detail.

8.6 The Interface with an Aggregate Trip Distribution Model

8.6.1 This section of the chapter discusses the interface of the proposed trip generation model with an aggregate distribution model. It's purpose is to put the developed model in the context of the whole design package, showing how the model would be applied, in conjunction with the distribution model, to the development control of large foodstores. It is not the purpose of this thesis to develop the applications package required for the implementation of such a model in practise but rather to prove that a trip generation model can be built on household characteristics.

Variable Name	Multiple Correlation	r2 value	Adjusted r2 value
No. of Cars (J)	0.65	0.42	0.38
Employment (Q)	0.74	0.54	0.47
No. of Licences (L)	0.79	0.62	0.52
No. in Household (N)	0.88	0.77	0.68

TABLE 68

The Prediction of Personal Accessibility from the Independent Variables using the Means Data Matrix

8.6.2 The research objectives sought to establish a reliable basis for private-car trip prediction to large foodstores based on household characteristics. The developed model comprises three sub-models, one of which relates to trip-rate. This model is based on the means data matrix and on the variables income (K), number in the household (N), personal accessibility of the principal shopper (R) and the number of licences (L). The form of the model is given below :

$$F = 1.0 + 0.346K - 0.027N + 0.119R - 1.117L$$

8.6.3 The zonal base chosen is at Ennumeration District (ED) level as this is highly disaggregate, with respect to a strategic development control model, and data at a lower level cannot easily be obtained. By multiplying the trip-rate for each ED in the study area by the number of households the potential number of weekly, bulk-buying, car trips is obtained. Thus for each ED the generated number of trips per week is calculated.

8.6.4 The private-car arrivals at each store in the survey area would require to be surveyed either by customer interview or by vehicle count, as the total sales figure cannot be used because it includes all shopping trips. There is also a units incompatability in that trips to each store is equated to sales at each store so that the generated trips would require to be multiplied by an expenditure per trip factor. This latter problem can be accommodated since there is an expenditure sub-model for each ED.

8.6.5 There is therefore a choice between either a singly or doubly-constrained distribution model. The doubly-constrained model has the advantage that the distributed traffic can be assigned to the road network but has the disadvantage that the modal split at each store would have to be found so that the total sales per week from car trips could be calculated. Given that the number of large stores is relatively small, it is proposed that a doubly-constrained distribution model should be used.

8.7 The Form of the Proposed Distribution Model

8.7.1 The form of the model is :

$$S_{ij} = k_i k_j' O_i C_i S_j / f(T_{ij})$$

where $k_i = [\Sigma\, k_j S_j / f(t_{ij})]^{-1}$

and $k_j = [\Sigma\, k_i O_i C_i / f(T_{ij})]^{-1}$

O_i = trips from ED i to store in ED_j
C_i = expenditure per trip in ED_i
S_j = private car based sales at store in ED j
$f(T_{ij})$ = deterrence function
and S_{ij} = total number of car-borne shopping trips from zone i to store in ED j.

The product of the constants k_i and k_j, for each production zone and attracting store respectively, ensures that both the row and column totals of the model matrix equal the row and column totals of the survey matrix. The model is subject to the two constraints,

$$\sum_i S_{ij} = O_i C_i \text{ at the production end, and}$$

$$\sum_i O_i C_i = \Sigma S_j \text{ at the attraction end.}$$

8.7.2 The generation term for each ED_i, $O_i C_i$, is the number of trips from the ED multiplied by the expenditure per visit, as predicted by the multiple regression sub-models. The attraction term, S_i, is the number of sales at each store. Further work in this area may prove a more complex attraction term to be a better estimator of the distribution pattern but in the context of the philosophy of the conceptual framework number of sales in considered an adequate proxy for store attraction. This is discussed further in Chapter 10.

8.7.3 The form of the deterrence function is usually based on one of the three mathematical functions[125] :

a) the power function, $f(T_{ij}) = T_{ij}^{\alpha}$
b) the exponential function, $f(T_{ij}) = \exp(\beta T_{ij})$
c) Tanner's function, $f(T_{ij}) = T_{ij}^{\alpha} \exp(\beta T_{ij})$

The calibration should include a testing of different functions to choose the function that best fits the empirical survey data, whether based on trip length or journey time; however this is seldom carried out in practise. Calibration involves finding the numerical value of the parameter or , or the two parameters and , which control the mean trip length or journey time. The simplest procedure is to run the model for a range of parameter values thereby calibrating the model by trial and error. A more efficient method is to adopt a systematic search routine such as the Fibbonaci, or golden-section, search algorithm[126], or the Newton-Raphson method[127,128]. It is proposed that journey time should be used, as argued in Chapter 4, on grounds of ease of implementation and the required strategic level of control unless further work suggests a more complex function is better.

8.8 The Design Procedure for the Distribution Model

8.8.1 The distribution of the trips generated at ennumeration district level may be achieved using a fully constrained model of the form,

$$S_{ij} = k_i k_j O_i C_i S_j / T_{ij}^{\alpha}$$

where $$k_i = [\Sigma k_j \, S_j / T_{ij}^{\alpha}]^{-1}$$

and $$k_j' = [\Sigma k_i \, O_i C_i / T_{ij}^{\alpha}]^{-1}$$

subject to the constraints,

$$\sum_j S_{ij} = O_i C_i$$

and $$\sum_i O_i C_i = \sum_j S_j$$

This model would produce a distribution matrix whose origins would be the ennumeration districts in the study area and whose destinations will be the stores. A matrix of journey times would also be produced using the same origin and destination base. The mathematical function of transport impedance proposed is the power function based on journey time.

8.8.2 An initial value of the calibration parameter α , is then selected and the zoning balancing factors, k_i and k_j' , calculated. The balancing factors are solved using an iterative process by assuming any intial value for either k_i or k_j'. Once the calculation converges the balancing factors are substituted into the distribution model and the model origin and destination matrix is calculated. Then the mean journey time of all trips in the model origin and destination matrix is calculated and this is compared to the mean survey journey time. The value of may then require to be adjusted. If necessary another calibration parameter may require to be selected until the calibration criteria are satisfied.

8.8.3 The survey area chosen has the advantage that few trips come from the rural areas outwith the green belt around

Edinburgh City boundary. Within the study area every household is within a twenty minute driving time contour of a large foodstore. However in an area where the study area cannot be so closely defined boundary problems will exist. This will mean that the study area will require to be enlarged until a suitable watershed in the market exists. The enlarged area will mean that other stores may be included.

8.8.4 The problem of catchment area definition relates to the distribution of shopping trips and the attraction of competing stores. It does not relate to the generation, or potential generation, of this type of shopping trip. The development of measures of attractiveness, although discussed in the context of spatial accessibility in Chapter 4, is the subject of further work. This should include the value of the power function within the deterrance measure and the degradation of the power of attraction with distance.

8.8.5 The above paragraphs have stated a preference for a doubly-constrained model on the grounds of a better representation of the actual shopping pattern and the ability to assign the predicted trips to the road network thereby directly assessing the impact on specific roads and junctions. However a simpler procedure would be a singly-constrained model where,

$$\sum_j T_{ij} = O_i$$

This would not involve the expenditure sub-model nor the need to survey each store to establish modal trip patterns. The store attraction distribution would then be a probability function based on some proxy measure of attraction, such as floor area, and a deterrance function. The general form of the probability function would be,

$$P_{ij} = \frac{W_j^{\lambda_1} d_{ij}^{-\lambda_2}}{\sum_j W_j^{\lambda_1} d_{ij}^{-\lambda_2}}$$

where P_{ij} is the probability of a consumer in zone i shopping at store j and W_j is the store attraction index. The model would then be of the form

$$S_{ij} = O_i C_i \frac{W_j^{\lambda} d_{ij}^{-\lambda_2}}{\sum_j W_j^{\lambda_1} d_{ij}^{-\lambda_2}}$$

This agrees with the probabilistic nature of the shopping market as proposed by Huff.(38)

8.9 Concluding Remarks on the Interface with an Aggregate Distribution Model

8.9.1 The objective of the thesis is to establish a disaggregate trip generation model, for private-car trips to large foodstores, using household characteristics based on census data. This having been achieved the model has been put into the context of the total applications package required for development control of these stores. The proposed trip generation model requires to be tested over the whole of Edinburgh City and in other areas if it is to be used generally.

8.9.2 The development of a strategic development control model will require the following outlined stages :

1) Census data for the relevant household variables extracted for every ED and the total number of trips and total expenditure calculated from the equations. This needs to be done only once and thereafer would be updated every ten years, or if a major

residential land-use change occured. The duration of stay, which is a by-product of the development of the trip generation model potentially offers the possibility of estimating car parking requirements. Further work requires to be done to distribute the total duration of stay from each ED to the large foodstores.

ii) The first stage provides a zonal system with numbers of private-car trips for each zone. These require to be distributed to the stores in the designated study area. If the doubly-constrained model is used the total expenditure will have to be calibrated with the total car-borne sales. Alternatively a singly-constrained distribution model using a probability function, as described earlier in the chapter, and a deterrance function based on journey time or cost could be used. These alternatives require to be tested as part of the future development of the total applications package.

8.9.3 The major advantages of the proposed method over existing methods are ease of application, both at the generation and distribution stages, economy of time, in that neither household nor store interview surveys require to be carried out, increased accuracy based on local area characteristics rather than extrapolation from other surveys in other areas and the ability to build an area-wide model thereby being able to assess the impact of a new store in the area or of a store ceasing to trade in the area. The trip generation model developed in this thesis combined with a standard aggregate distribution technique provides a unique solution to the dual problems of the context dependence of aggregate models and the data acquisition demands of disaggregate models.

8.9.4 From a developer's point of view once the total application model has been constructed new store locations could be chosen to maximise the number of potential trips. The trip generation model could be used to predict the number of trips in any given area, without giving the distribution of these trips with respect to the new and existing stores in the area. Thus the three sub-models could be used in a store-specific application. This would mean that a catchment area was defined around an existing store and the models applied to the ennumeration districts within the catchment area. Thus for any store the number of trips, duration of stay and expenditure per week could be estimate for its catchment area. This has the advantage over existing methods in that the models relate to local characteristics, the disadvantage, as mentioned above is that the effect of other stores in the system is not included. There is no guarantee that the households within the catchment area of a store will use that store, however it may be a guide to possible usage and is potentially superior to trip generation calculations based on floor-area. A comparison of the two methods in a store-specific application should be the subject of further work.

8.10 A Listing of the Major Points Emerging from the Analysis

8.10.1 The bulk-buying of food by private-car can be represented as a separate, two stage process, i.e. the decision to make the trip and the subsequent choice of store. This means that it can be structured as a two-stage modelling process of trip generation and distribution.

8.10.2 There is a strong linear relationship between the use of large foodstores by private-car and certain houshold characteristics which can be extracted from census data.

8.10.3 Bulk-purchase food shopping by private car can be identified as distinct from general shopping thereby providing a dependent variable of usage with which the relationships with household characteristics can be measured.

8.10.4 This usage variable is best measured by the three separate variables of trip frequency, duration of stay and expenditure per visit rather than a usage factor. A relative shopping term, where bulk-purchase food shopping is expressed as a percentage of total shopping, does not add to the explanation of the usage variable.

8.10.5 Two models were investigated based on factor variables and individual variables. The factor-based model in all cases is inferior to the individual-based model.

8.10.6 The strong relationship, based on the canonical correlation analysis, between household characteristics and large store usage indicates that no major independent variables have been omitted.

8.10.7 The proposed model predicts 41% of the total variation in large store usage at individual household level. Although this level of prediction is not satisfactory in the context of a strategic development control model it is a creditable performance when one considers the large variation at this maximum level of disaggregation.

8.10.8 This base level of accuracy means that when the model is aggregated to ennumeration district level the prediction is extremely high at 95%. Ennumeration district is the base zoning system for all transportation and physical planning zoning, therefore the generation model can be readily interfaced with a standard trip distribution model.

8.10.9 The proposed model comprises three sub-models which not only predict the number of trips per ennumeration district but the duration of stay and the bulk-buying expenditure.

8.10.10 The model shows that the spatial accessibility of a household to large stores does not affect the number of trips emanating from the household. This supports the theory that the choice process can be regarded as two separate stages.

8.10.11 The advantages of the proposed model are :

i) ease of application and economy of time because the required data is extracted from census data.

ii) increased accuracy because the model is based on local characteristics.

iii) an ability to develop an area model, in conjunction with a standard trip distribution model, incorporating the interacting forces of different shops within the distribution stage.

iv) the combination of the advantages of a disaggregate model at the generation stage interfacing with a standard, aggregate model at the distribution stage, overcoming the disadvantages of the data requirements and the context dependency of the two types of models respectively.

v) its use in a store-specific application if a catchment area is defined around the store in question.

CHAPTER 9
SUMMARY AND CONCLUSION

9.1 Introduction

This chapter summarises the research programme highlighting the salient points of the thesis. The summary includes all chapters of the thesis.

9.2 The objective of the research programme is to produce a private-car trip generation model, based on local household area characteristics, for use in the strategic control of large foodstores. Also to discover the level of disaggregation at which a general model can be developed and to show how the developed model interfaces with a standard, aggregate distribution model. The thesis began with the historical background to the study discussing the reasons for the growth of this type of shopping in Britain. The following chapter discussed the problems caused by these stores and the current methods used to predict their traffic attraction. These methods are based on the floor-area of the store and it is shown that this is unreliable and varies with local area characteristics. Various recent research papers recognise the need for a generalised model of trip generation based on local area characteristics but no model exists at the present time. The estimation of parking spaces is also unreliable when based on the same criteria as trip-rate.

9.3 The chapter on consumer behaviour relates consumer behaviour theory to the observed characteristics of bulk-buying shoppers. This identifies important variables which are related to store usage and consumer choice. The chapter on accessibility discusses the place of accessibility within consumer choice and store competition. Accessibility is seen to comprise three elements :

a) the availability of a private car
b) the availability of the principal shopper
c) the availability of the store

For a private-car shopping trip to take place all three have to coincide. These elements represent the personal accessibility of the household and are part of the trip generation model. The spatial accessibility of each store comprises an attraction term and a spatial deterrence term. This relates to the distribution of trips within the competing framework of stores. It only applies in an area where the consumer has an existing range of store choice and may not apply where no store exists and a store is to be provided. To study the relationship between household characteristics and store usage competition had to be held constant. This is achieved by selecting groups of households which have equal store opportunities.

9.4 The research objectives and conceptual framework were then developed. It was not possible to develop an a priori model of store usage based on household characteristics. The study is therefore designed as an investigative research programme based on two conceptual models. The first model proposed that store usage is a composite variable comprising frequency of use, duration of stay and expenditure per visit and is predicted by three composite, independent factors of household variables. The three factors are based on household structure, employment and lifestyle. If this model proved acceptable a graduated table of store usage, based on the composite usage index, would be constructed. The disadvantage of this model is the application of the usage index. The second model proposed that the three store usage variables are linearly related to household characteristics and can be predicted from them directly. The application of this model is much easier than the previous model as the three variables are identifiable.

9.5 The model defined in principle by the research design relates to the strategic control of large foodstore development. This implies that the model must be efficient in time and effort with a predictive capability superior to existing procedures. The data requirements of the model should not therefore be onerous and should be based on census data. These data are accessible and regularly updated. The variables not included in census data will be estimated from other intercorrelated variables or external sources.

9.6 The methods of analyses used were multi-variate, statistical techniques based on the SPSS computer suite of programs. The survey area was defined as the Edinburgh city boundary and fifteen sub-areas, each of twenty-seven households, were chosen at random using a hierarchical sampling technique based on postal-codes. The household questionnaire was designed to measure the identified variables, as indexed, and a pilot survey was carried out to test the design. Following the main survey of four hundred households, fifteen sub-area data files were constructed and initial sub-area profiles prepared.

9.7 The analysis of the data commenced with the establishment of a Pearson bivariate correlation matrix which shows the strength of the relationship between each variable pair. The two shopping expenditure variables are strongly related to the independent variables but the other dependent variables show few consistent relationships. The non-homogeneity of certain sub-areas was investigated and its presence found to be insignificant in its influence on the data structure. No evidence of non-linear relationships was found. A principal components analysis was carried out to establish what is being measured on the dependent side of the equation and how it is measured by the independent variables. The total data matrix verified the factor model, postulated by the conceptual framework, but the structure does not consistently exist at sub-area level. Conversely the canonical correlation shows that within each area a strong relationship exists between the two variable sets, but at total data matrix level the canonical coefficient drops from 0.90 to 0.64. This implies that although the objectives of the research can be achieved within the sub-areas, at household level, a general model for all sub-areas cannot be used.

9.8 The second model, based on the individual variables, was then investigated using multiple regression analysis. Again the areal variation is large and the prediction level is variable. However, if the mean of each variable within the sub-area is calculated and a means data matrix constructed, the three store usage variables of frequency of use, duration of stay and expenditure per week can be predicted accounting for approximately 90% of the variance in these variables.

These multiple regression equations were developed to achieve three sub-models that are stable from area to area. These models are :

$$F = 1.0 + 0346K - 0.027N + 0.119R - 1.117L$$

$$B = 0.81 - 0.026P + 0.001S + 0.027R$$

$$D = 13.1 - 15.315L - 0.459N + 6.055K + 1.821R + 2.272M$$

where

F = Frequency of store use/week
B = Duration of stay at store/week
D = Expenditure at store/week
K = Income of the household
L = Number of licences in the household
M = Number in the household
N = Mean age of the household
P = SEG of head of household
R = Personal accessibility of principal shopper
S = Spatial accessibility of household to stores

The trip frequency and expenditure variable models account for 70% of the variance in the independent variable. The duration of stay model explains 42%. These percentages are adjusted for the number of variables and sample size. The sample size (i.e. fifteen) of the means data matrix depresses the actual percentages which are 80% and 58% respectively. A higher level of prediction can be achieved but the stability of the model decreases.

9.9 The areal variation comprises two elements; within-area and between-area variation. When areas are aggregated the total variation becomes so large that the prediction level drops significantly. The means data matrix smooths the within-area variation to provide sufficient, but not excessive, between-area variation to achieve a high level of prediction. The areal variation between areas is caused by a lack of variance in variables in certain areas, due to uniform groupings, and the individuality of human behaviour.

9.10 It is possible, therefore, to develop a stable, predictive trip generation model based on the means data matrix. The model consists of three sub-models relating to trip-rate, duration of stay and expenditure per week. These apply to trip generation, car parking capacity and market potential respectively. The model based on composite factors proved unsatisfactory.

9.11 The level of disaggregation achieved is small, based on groups of twenty-seven households, and is impractical. The smallest disaggregation achievable in practise is at ennumeration district (ED) level, which is of the order of one hundred and twenty households. This is also the zoning base from which all other transportation zones are aggregated. The study area would therefore be divided into ED's and the trip-rate, duration and expenditure levels calculated for each ED. If this was unacceptable on cost grounds the ED's can be aggregated to form sub-areas within transportation zones.

9.12 The effect of competition, represented by spatial accessibility, only appears in the duration sub-model. This implies that in an area of existing stores a new store will redistribute the existing car-borne trips, increase or decrease the duration of stay at these stores and redistribute the expenditure. Trips by other modes, notably walking trips, around the new store will be generated. This supports the theory of the thesis in that the generation and distribution stages of the car-borne shopping trip can be separated. Household characteristics determine the need to bulk-buy and once this need has been recognised the household looks at the alternatives and chooses a store.

9.13 Although not part of the thesis the interface of the trip generation model with the aggregate trip distribution model is discussed and is based on a systems approach. This means that a model of the study area pattern for car-borne, bulk-buying shopping is constructed based on the local area trip generations discussed above. The distribution model proposed is a doubly-constrained aggregate distribution model of the form,

$$S_{ij} = k_i k'_j O_i C_i S_j / T_{ij}^{\alpha}$$

where $k_i = [\Sigma\, k'_j\, S_j / T_{ij}^{\alpha}]^{-1}$

and $k_j' = [\Sigma\, k_i O_i C_i / T_{ij}^{\alpha}]^{-1}$

subject to the constraints,

$$\sum_j S_{ij} = O_i C_i$$

and $\sum_i O_i C_i = \sum_j S_j$

where S_{ij} = the total car-borne sales from zone i to store j

O_i = total car-borne trips from zone i

C_i = weekly expenditure/household from zone i

S_j = total car-borne sales at store j

T_{ij}^{α} = a deterrance power function

k_i, k_j', α = model parameters

9.14 Once the model is calibrated a mathematical understanding of the shopping pattern in the study area is achieved. The doubly-constrained distribution model also means that the trips can be assigned to the road network to investigate potential capacity problems. A proposed store can then be added to the model to study the effects on the trip distribution. The zonal trip-rates will be updated as census data is updated.

9.15 The research objectives of the thesis have therefore been achieved in that a strategic, disaggregate trip generation model for private-car use of large foodstores has been developed. The level of disaggregation of the model has been fully investigated and its interface with an aggregate distribution model explained. The following chapter identifies areas of further development.

CHAPTER 10
SUGGESTIONS FOR FURTHER RESEARCH

10.1 Introduction

This chapter suggests a number of areas where further work could be undertaken. Many of these areas have been mentioned in the text. They range from the city-wide development and testing of the proposed model to the improved measurement of specific variables.

10.2 The Development and Testing of a City-Wide Model

10.2.1 The proposed generation model has been tested with respect to the four hundred household sample, however, the development of a city-wide model needs to be investigated. This would initially be an extension of the existing study in Edinburgh but studies in other towns and cities require to be undertaken to test the national generality of the model.

10.2.2 Comparison must be made with existing methods of trip prediction ensuring that the catchment areas are comparable. This would involve including all the stores in a study area so that the city-wide model could be compared to the store-specific models. It would also be of interest to compare the store-specific approach using both the existing disaggregate methods and the new disaggregate equations.

10.3 Estimating the Hourly and Daily Trip Pattern

10.3.1 The time and day of each shopping trip is recorded on the shopping diary questionnaire for the household sample. At the strategic level the weekly total of trips combined with the daily pattern of bulk-buying shopping, which is well-documented, is sufficient. However the accuracy and flexibility of the model would be improved if a sub-model could be developed on an hourly and/or daily basis. This could provide the basis for the study of a range of critical scenarios.

10.4 Further Development of the Model

10.4.1 The model was developed in an area of competing large stores. Every household in the area, with a car, has access to a large store within a twenty-five minute driving time. A further development of the model would be the study of areas without such stores, to evaluate the potential generation from the area. The investigation would adopt the same disaggregate model philosophy but would involve attitudinal surveys to establish the potential level of use with respect to household characteristics.

10.4.2 The model could be further developed for other modes of travel. This may involve modal sub-models for walking and bus trips. Each modal sub-model would require its own network system but would use a common zoning system due to the highly disaggregate ennumeration district base.

10.4.3 The philosophy of this thesis, using a disaggregate generation model with an aggregate distribution model could be investigated for other areas of development control, such as housing, offices and recreation. Each area constitutes a major study but the possibility of developing a family of development control models based on census data is most attractive and should be pursued.

10.5 Measurement of the Variables

10.5.1 The previous suggestions have dealt with the general development of the model and its testing. This area of further work is more specific in that it relates to the measurement of individual variables. Freezer ownership, income and SEG were category-based variables; although income can be thought of as numeric. Some of the other variables were in effect category variables in that the range of values was limited. Car ownership and number of licenses are examples of this categorisation. The dependent variables of frequency and duration also suffered from the effect in that the consumer rounded off the duration to the nearest hour or half- hour and frequency was either once per week, fortnight, or month.

The latter benefited from the weekly standardisation. This stepped-effect worked against the linear correlation since the measurements grouped around certain values. Further work requires to be carried out on the indexing and measuring of these variables so that a more continuous measure is obtained. The inclusion of income and personal accessibility in the model means that census data cannot supply all the information for the model. Further work requires to be carried out to establish independent measures for income and personal accessibility, thereby obviating the need to rely on other independent variables or on global data such as the National Expenditure Survey.

10.5.2 The presence of zero values in the dependent usage variables did not impair the predictive capacity of the model based on the means data. However the zero values did affect the sub-area models. Further work requires to be carried out to investigate whether it is possible to predict zero usage of large stores in a car-owning household. If the model could be amended to anticipate zero usage the prediction at household level would be improved.

10.6 The Development of the Distribution Model

10.6.1 The proposed distribution model is compatible with the research objectives in that it is aggregate and proven in its application. The attraction term is based on either number of sales, if the proposed model is used, or floor-area, if the singly-constrained model is used. However the chapter on accessibility highlighted the work to date on attraction terms for large stores. These more complex measures should be tested once a city-wide model has been developed to judge whether the increased complexity is justified with respect to cost-effectiveness and distributional accuracy.

10.6.2 The same philosophy applies to the deterrance function where journey time is used. Again the chapter on accessibility discussed more complex measures based on generalised cost and these should also be investigated to establish their contribution to the model's accuracy.

10.6.3 Finally other forms of distribution model should be investigated and their results compared to the standard spatial interaction model. A range of distribution models is available, including those which operate at a disaggregate level. These models should however be sympathetic to the philosophy of the design method in that they should provide an easily applied and efficient tool for the strategic planning control of large foodstores.

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"A DISAGGREGATE TRIP GENERATION MODEL FOR THE STRATEGIC PLANNING CONTROL OF PRIVATE CAR TRIPS TO LARGE FOODSTORES"

G. McL. HAZEL

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Ph.D. THESIS

CRANFIELD INSTITUTE OF TECHNOLOGY

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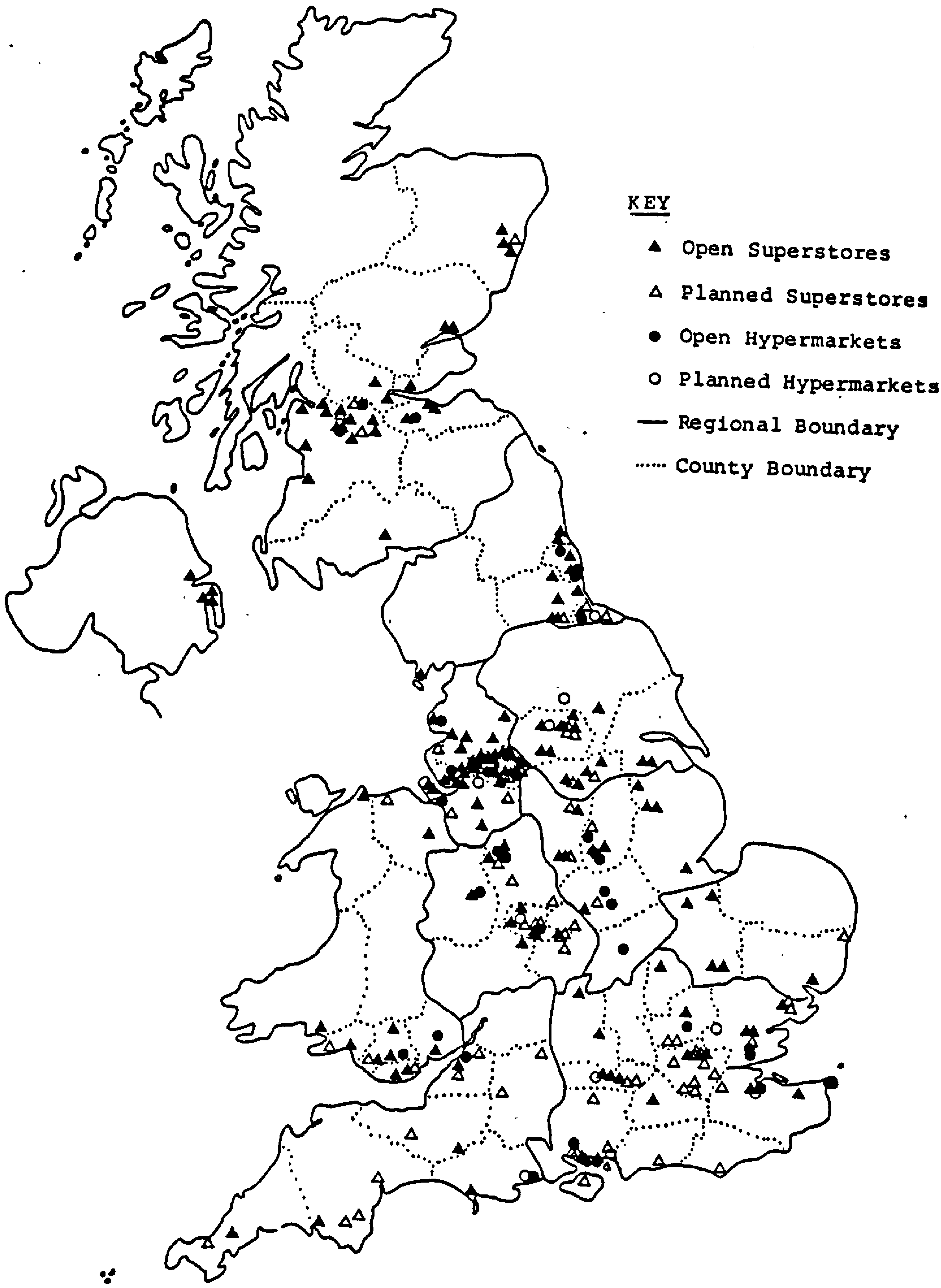
APPENDIX A



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Map and Table showing Distribution of Hypermarkets and Superstores, Open and Planned, and their sizes

Location (District)	Retailer	Net Floorspace Sq.m. (Sq.ft.)	Gross Floorspace Sq.m. (Sq.ft.)	Car Parking Spaces	Opening Date
AVON					
Bristol (Bristol City)	Asda	3,200 (34,000)	4,900 (53,000)	564	1978
Bristol (Northavon)	Carrefour	8,400 (90,000)	16,500 (178,000)	1,700	1978
Nailsea, Bristol (Woodspring)	Super Key	2,500 (27,000)	5,000 (54,000)	-	Planned
Yate (Northavon)	Tesco	3,300 (35,000)	6,300 (68,000)	500	Planned
BEDFORDSHIRE					
Kempston (North Bedfordshire)	J.Sainsbury	3,200 (34,000)	5,900 (63,000)	500	1975
BERKSHIRE					
Bracknell (Bracknell)	SavaCentre	-	14,500 (156,000)	735	Planned
Calcot, Reading (Newbury)	SavaCentre	7,000 (75,000)	13,900 (150,000)	1,350	Planned
Lower Earley (Wokingham)	Asda	3,900 (42,000)	6,500 (70,000)	680	1979
Reading (Reading)	Tesco	3,300 (35,000)	5,100 (55,000)	Shared	1976
Tilehurst (Reading)	Super Key	3,000 (32,000)	5,000 (54,000)	221	1978
Wokingham (Wokingham)	Tesco	3,000 (32,000)	5,100 (55,000)	300	Planned
CAMBRIDGESHIRE					
Bar Hill (S.Cambridgeshire)	Tesco	3,000 (32,000)	4,600 (50,000)	500	1977
Cambridge (Cambridge City)	Co-op (Cambridge Society)	4,300 (46,000)	7,200 (77,000)	496	1978

Location (District)	Retailer	Net Floorspace Sq.m. (Sq.ft.)	Gross Floorspace Sq.m. (Sq.ft.)	Car Parking Spaces	Opening Date
CAMBRIDGESHIRE (Contd.)					
Peterborough (Peterborough City)	Big I	4,100 (44,000)	6,600 (71,000)	600	1979
Wisbech	Super Key	2,600 (28,000)	4,600 (50,000)	400	1974
CHESHIRE					
Chester (Chester City)	Tesco	4,600 (50,000)	7,400 (80,000)	550	Planned
Crewe (Crewe & Nantwich)	Asda	4,100 (44,000)	6,700 (72,000)	600	1979
Ellesmere Port (Ellesmere Port)	Lewis's	6,300 (68,000)	9,600 (103,000)	3,000	1976
Macclesfield (Macclesfield)	Co-op (North Midland Soc.)	4,200 (45,000)	5,600 (60,000)	-	Planned
Warrington (Warrington)	Fine Fare	7,400 (80,000)	10,100 (109,000)	1,500	Planned
Widnes (Halton)	Asda	4,400 (47,000)	6,200 (67,000)	750	1969
Widnes (Halton)	Co-op (Warrington Soc.)	4,600 (50,000)	7,200 (78,000)	800	1975
Winsford (Vale Royal)	Fine Fare	4,600 (50,000)	6,300 (68,000)	750	1976
CLEVELAND					
Hartlepool, (Middleton Grange Hartlepool)	Fine Fare	4,600 (50,000)	7,400 (80,000)	480	Planned
Middlesbrough (Middlesbrough)	Fine Fare	5,600 (60,000)	8,500 (91,000)	688	Planned
South Bank (Langbaurgh)	Asda	3,700 (40,000)	5,600 (60,000)	-	Planned

Location (District)	Retailer	Net Floorspace Sq.m. (Sq.ft.)	Gross Floorspace Sq.m. (Sq.ft.)	Car Parking Spaces	Opening Date
CLEVELAND (Contd.)					
Stockton-on-Tees (Stockton-on-Tees	Asda	3,900 (42,000)	6,700 (72,000)	454	1970
Thornaby (Stockton-on-Tees)	Woolco	6,200 (67,000)	9,600 (103,000)	950	1968
CORNWALL					
Camborne (Kerrier)	Big I	2,800 (30,000)	3,700 (40,000)	400	Planned
Truro (Carrick)	Tesco	2,600 (28,000)	4,600 (50,000)	Shared	1978
CUMBRIA					
Barrow-in Furness (Barrow in-Furness)	Asda	2,900 (31,000)	4,600 (50,000)	550	1974
DERBYSHIRE					
Chesterfield (Chesterfield)	Big I	-	3,700 (40,000)	-	Planned
Chesterfield (Chesterfield)	Preston	3,300 (35,000)	5,100 (55,000)	150	1969
Derby, Spondon (Derby)	Asda	3,700 (40,000)	5,600 (60,000)	-	Planned
Mickleover (Derby)	Hillards	3,200 (34,000)	4,600 (49,000)	371	1979
Sinfin (Derby)	Fine Fare	3,300 (35,000)	4,600 (50,000)	850	1979 (1977)
DEVON					
Exeter (Exeter City)	Big I	3,000 (32,000)	4,300 (46,000)	-	Planned
Lee Mill (South Hams)	Tesco	2,800 (30,000)	4,600 (50,000)	5,000	Planned

Location (District)	Retailer	Net Floorspace Sq.m. (Sq.ft.)	Gross Floorspace Sq.m. (Sq.ft.)	Car Parking Spaces	Opening Date
DEVON (Contd.)					
Newton Abbot (Teignbridge	Tesco	3,700 (40,000)	5,600 (60,000)	400	Planned
Plymouth (Plymouth City)	Asda	2,900 (31,000)	4,600 (50,000)	557	1976
DORSET					
Bournemouth (Bournemouth)	Big I	5,700 (61,000)	8,500 (91,000)	500	Planned
Bournemouth (Bournemouth)	Woolco	6,900 (74,000)	10,300 (111,000)	1,650	1968
Weymouth (Weymouth & Portland)	Big I	2,900 (31,000)	3,800 (41,000)	550	1978
DURHAM					
Darlington (Darlington)	Big I	3,100 (33,000)	5,200 (56,000)	-	Planned
Darlington (Darlington)	Fine Fare	3,000 (32,000)	5,400 (58,000)	300	1978
Darlington (Darlington)	Wm.Morrison Supermarkets	3,400 (37,000)	5,000 (54,000)	-	1980
Newton Aycliffe (Sedgefield)	Fine Fare	2,600 (28,000)	4,100 (44,000)	280	1979
Peterlee (Easington)	Fine Fare	4,500 (48,000)	6,300 (68,000)	240	1975
Stanley (Derwentside)	Fine Fare	4,500 (48,000)	5,900 (63,000)	340	1977
EAST SUSSEX					
Eastbourne (Eastbourne)	Tesco	3,700 (40,000)	5,900 (63,000)	400	Planned

Location (District)	Retailer	Net Floorspace Sq.m. (Sq.ft.)	Gross Floorspace Sq.m. (Sq.ft.)	Car Parking Spaces	Opening Date
ESSEX					
Basildon (Basildon)	SavaCentre	6,500 (70,000)	13,900 (150,000)	1,000	1980
Chelmer Village (Chelmsford)	Asda	2,800 (30,000)	4,600 (50,000)	520	1979
Colchester (Colchester)	Tesco	2,800 (30,000)	4,600 (50,000)	400	Planned
Colchester (Colchester)	Tesco	4,200 (45,000)	6,500 (70,000)	700	Planned
Colchester (Colchester)	Tesco	2,800 (30,000)	4,800 (52,000)	250	1979 (1978)
Harlow (Harlow)	Tesco	6,500 (70,000)	9,500 (102,000)	-	Planned
Pitsea (Basildon)	Tesco	7,600 (82,000)	9,800 (105,000)	1,000	1978
South Woodham Ferrers (Chelmsford)	Asda	3,200 (34,000)	5,200 (56,000)	600	1978
Wickford (Basildon)	Not Available	2,700 (29,000)	3,600 (39,000)	100	Planned
GREATER LONDON					
Croydon (L.B.Croydon)	J.Sainsbury	3,300 (36,000)	6,000 (65,000)	500	Planned
Erith (L.B. Bexley)	Asda	4,300 (46,000)	7,200 (78,000)	500	Planned
Finchley (L.B. Barnet)	Tesco	3,300 (36,000)	4,800 (52,000)	300	1978
Ilford (L.B. Redbridge)	Cartiers (Ilford)	3,300 (35,000)	-	800	1979 (1976)
Park Royal (L.B. Ealing)	Asda	4,600 (49,000)	7,200 (78,000)	622	Planned

Location (District)	Retailer	Net Floorspace Sq.m. (Sq.ft.)	Gross Floorspace Sq.m. (Sq.ft.)	Car Parking Spaces	Opening Date
GREATER LONDON (Contd.)					
Stratford (L.B. Newham)	Big I	2,500 (27,000)	4,900 (53,000)	-	Planned
Sutton (L.B. Sutton)	Tesco	4,600 (50,000)	7,400 (80,000)	400	Planned
Thornton Heath (L.B. Croydon)	Tesco	4,700 (51,000)	6,500 (78,000)	400	Planned
Tottenham (L.B. Haringey)	Tesco	3,700 (40,000)	5,600 (60,000)	300	Planned
Walthamstow (L.B. Waltham Forest)	J.Sainsbury	2,600 (28,000)	4,200 (45,000)	350	Planned
Wood Green	Big I	-	5,600	-	Planned
GREATER MANCHESTER					
Ashton-under Lyne (Tameside)	Big I	3,100 (330,000)	4,800 (52,000)	500	Planned
Bolton (Bolton)	Asda	3,200 (34,000)	5,900 (64,000)	500	1970
Chadderton (Oldham)	Asda	3,300 (36,000)	5,800 (62,000)	560	1972
Failsworth (Oldham)	Co-op (Norwest Society)	3,700 (40,000)	5,800 (62,000)	530	1975
Failsworth (Oldham)	Wm.Morrison Supermarkets	5,600 (60,000)	-	200	1978
Farnworth (Bolton)	Asda	3,300 (35,000)	5,800 (62,000)	450	1979
Golborne (Wigan)	Asda	2,800	5,000	500	1972
Gorton (Manchester City)	Co-op (Co-operative Retail Services)	2,800 (30,000)	-	-	Planned

Location (District)	Retailer	Net Floorspace Sq.m. (Sq.ft.)	Gross Floorspace Sq.m. (Sq.ft.)	Car Parking Spaces	Opening Date
GREATER MANCHESTER (Contd.)					
Harpurhey (Manchester City)	Asda	4,300 (46,000)	6,800 (73,000)	700	Planned
Hindley (Wigan)	Co-op (Greater Lancastria Soc.)	2,700 (29,000)	4,100 (44,000)	500	1977
Horwich (Bolton)	Tesco	2,800 (30,000)	4,600 (50,000)	600	1974
Hyde (Tameside)	Fine Fare	7,000 (75,000)	9,800 (105,000)	600	1976
Ince-in Makerfield (Wigan)	Wm.Morrison Supermarkets	-	-	-	1979
Irlam (Salford City)	Tesco	6,800 (73,000)	9,700 (104,000)	980	1976
Manchester, Longsight (Manchester City)	Asda	3,200 (34,000)	5,400 (58,000)	475	1978
Middleton (Rochdale)	Woolco	6,000 (65,000)	9,300 (100,000)	816	1971
Oldham (Oldham)	Co-op (Pioneers Society)	4,600 (50,000)	7,500 (81,000)	450	1976
Rochdale (Rochdale)	Asda	3,800 (41,000)	6,600 (71,000)	1,000	1969
Rochdale (Rochdale)	Tesco	2,800 (30,000)	4,200 (45,000)	550	1973
Sale (Trafford)	Tesco	4,100 (44,000)	5,900 (64,000)	234	1977
Walkden (Salford City)	Tesco	5,400 (58,000)	7,400 (80,000)	900	1978

Location (District)	Retailer	Net Floorspace Sq.m. (Sq.ft.)	Gross Floorspace Sq.m. (Sq.ft.)	Car Parking Spaces	Opening Date
GREATER MANCHESTER (Contd.)					
Whitefield (Bury)	Preston	2,600 (28,000)	4,200 (45,000)	325	1975
Wigan (Wigan)	Asda	3,000 (32,000)	5,400 (58,000)	550	1970
Wythenshawe (Manchester City)	Co-op (Norwest Society)	5,600 (60,000)	9,800 (106,000)	1,400	1979 (1976)
HAMPSHIRE					
Basingstoke Chineham (Basingstoke & Deane)	Not available	3,700 (40,000)	5,000 (54,000)	Shared	Planned
Burlesdon Towers (Eastleigh)	Tesco	3,700 (40,000)	5,600 (60,000)	632	Planned
Chandlers Ford (Eastleigh)	Carrefour	5,200 (56,000)	11,500 (124,000)	1,100	1974
Gosport (Gosport)	Asda	3,000 (32,000)	4,700 (51,000)	347	1977
Gosport (Gosport)	Big I	3,200 (34,000)	4,100 (44,000)	300	1973
Littlepark (Havant)	Co-op (Portsea Island Society)	6,500 (70,000)	10,700 (115,000)	1,200	Planned
Portsmouth (Portsmouth City)	Tesco	3,700 (40,000)	5,900 (64,000)	Shared	1978
Southampton (Southampton City)	Tesco	3,700 (40,000)	5,600 (60,000)	500	Planned
Waterlooville (Havant)	Asda	3,300 (36,000)	5,600 (60,000)	600	Planned
HEREFORD AND WORCESTER					
Bromsgrove (Bromsgrove)	Fine Fare	3,500 (38,000)	4,900 (53,000)	380	1979

Location (District)	Retailer	Net Floorspace Sq.m. (Sq.ft.)	Gross Floorspace Sq.m. (Sq.ft.)	Car Parking Spaces	Opening Date
HERTFORDSHIRE					
Boreham Wood (Hertsmere)	Tesco	2,900 (31,000)	4,600 (50,000)	300	Planned
Hatfield (Welwyn Hatfield)	Woolco	6,700 (72,000)	9,500 (102,000)	1,250	1972
Stevenage (Stevenage)	Tesco	3,200 (34,000)	4,800 (52,000)	600	1973
Watford (Watford)	Tesco	4,200 (45,000)	6,000 (65,000)	450	Planned
HUMBERSIDE					
Scunthorpe (Scunthorpe)	Asda	2,800 (30,000)	4,500 (48,000)	5113	1976
Scunthorpe (Scunthorpe)	Co-op (Co-operative Retail Services)	2,800 (30,000)	3,700 (40,000)	-	1979
ISLE OF WIGHT					
Newport (Medina)	Big I	3,000 (32,000)	5,300 (57,000)	-	Planned
KENT					
Broadstairs (Thanet)	Co-op (Royal Arsenel Soc.)	6,200 (67,000)	9,900 (107,000)	900	1977
Canterbury (Canterbury City)	Super Key	2,800 (30,000)	4,500 (48,000)	400	1979
Chatham (Medway)	Fine Fare	3,100 (33,000)	6,000 (65,000)	400	1978
Chatham (Medway)	Tesco	5,900 (63,000)	8,200 (88,000)	500	Planned
Chatham (Hempstead Valley Medway)	SavaCentre	5,900 (64,000)	13,000 (140,000)	2,000	1978
Swanley (Sevenoaks)	Asda	4,000 (43,000)	6,700 (72,000)	410	Planned

Location (District)	Retailer	Net Floorspace Sq.m. (Sq.ft.)	Gross Floorspace Sq.m. (Sq.ft.)	Car Parking Spaces	Opening Date
LANCASHIRE					
Blackburn (Blackburn)	Co-op (Blackburn Society)	3,200 (34,000)	4,100 (44,000)	330	1977
Blackpool (Blackpool)	Fine Fare	4,700 (51,000)	9,100 (98,000)	500	1979
Blackpool, Marton (Blackpool)	Co-op (Greater Lancastria Society)	5,300 (57,000)	9,800 (106,000)	1,000	1979
Colne (Pendle)	Asda	3,100 (33,000)	5,700 (61,000)	500	1971
Preston (Preston)	Asda	3,600 (39,000)	8,900 (96,000)	247	1967
Rawtenstall (Rossendale)	Asda	3,200 (34,000)	4,900 (53,000)	430	1977
Whittle-Le-Woods (Chorley)	Asda	3,200 (34,000)	4,900 (53,000)	536	1978
LEICESTERSHIRE					
Braunstone (Blaby)	Asda	3,700 (40,000)	6,100 (66,000)	660	Planned
Hinckley (Hinckley & Bosworth)	Asda	2,600 (28,000)	4,400 (47,000)	320	1972
Leicester, Oadby (Oadby & Wigston)	Woolco	5,900 (63,000)	8,500 (92,000)	600	1967
Leicester, Thurmaston (Charnwood)	Co-op (Leicestershire	5,800 (62,000)	7,700 (83,000)	800	1975

Location (District)	Retailer	Net Floorspace Sq.m. (Sq.ft.)	Gross Floorspace Sq.m. (Sq.ft.)	Car Parking Spaces	Opening Date
LINCOLNSHIRE					
Gainsborough (West Lindsay)	Big I	3,300 (35,000)	4,600 (50,000)	400	1977
Lincoln (Lincoln City)	Co-op (Lincoln	2,500 (27,000)	3,400 (37,000)	280	1978
Lincoln (Lincoln City)	Tesco	3,300 (36,00)	4,600 (49,000)	200	1974
Spalding (South Holland)	Super Key	2,700 (29,000)	5,400 (58,000)	400	1978
MERSEYSIDE					
Birkenhead (Wirral)	Asda	3,100 (33,000)	5,600 (60,000)	425	1976
Birkenhead Woodchurch (Wirral)	Co-op (Co-operative Retail Services)	4,400 (47,000)	6,800 (73,000)	250	1972
Huyton (Knowsley)	Asda	3,200 (34,000)	4,900 (53,000)	536	1977
Kirkby (Knowsley)	Co-op (Greater Lancastria Society)	5,900 (64,000)	10,000 (108,000)	-	1978
Liverpool (Liverpool City)	Co-op (Co-operative Retail Services)	3,100 (33,000)	4,900 (53,000)	325	1979
Southport (Sefton)	Big I	4,200 (45,000)	5,900 (64,000)	500	Planned
St Helens (St Helens)	Co-op (St Helens Soc.)	2,700 (29,000)	3,600 (39,000)	-	1978
St Helens (St Helens)	Wm.Morrison Supermarkets	3,100 (33,000)	3,700 (40,000)	500	1978 (1971)

Location (District)	Retailer	Net Floorspace Sq.m. (Sq.ft.)	Gross Floorspace Sq.m. (Sq.ft.)	Car Parking Spaces	Opening Date
NORTH YORKSHIRE					
Harrogate (Harrogate)	Wm.Morrison Supermarkets	5,100 (55,000)	-	-	Planned
York Huntingdon (Ryedale)	Asda	3,000 (32,000)	5,600 (60,000)	628	1974
NORTHAMPTONSHIRE					
Northampton, Weston Favell (Northampton)	Tesco	9,900 (107,000)	13,900 (150,000)	1,600	1974
NORTHUMBERLAND					
Blyth (Blyth Valley)	Presto	2,800 (30,000)	4,200 (45,000)	Shared	1972
NOTTINGHAMSHIRE					
Arnold (Gedling)	Fine Fare	4,600 (50,000)	7,200 (77,000)	620	1978
Bulwell (Nottingham City)	Co-op (Greater Nottingham Society)	2,700 (29,000)	4,200 (45,000)	130	1978
Mansfield (Mansfield)	Tesco	2,800 (30,000)	4,400 (47,000)	519	Planned
Nottingham (Rushcliffe)	Asda	5,100 (55,000)	9,700 (104,000)	1,000	1966
Nottingham (Nottingham City)	Tesco	5,600 (60,000)	7,400 (80,000)	Shared	1978
Sutton-in-Ashfield (Ashfield)	Fine Fare	5,900 (64,000)	8,600 (93,000)	860	1978

Location (District)	Retailer	Net Floorspace Sq.m. (Sq.ft.)	Gross Floorspace Sq.m. (Sq.ft.)	Car Parking Spaces	Opening Date
OXFORDSHIRE					
Banbury (Cherwell)	Big I	2,700 (29,000)	3,900 (42,000)	-	1977
Wheatley (South Oxfordshire)	So-Lo	2,700 (29,000)	3,500 (38,000)	350	1978
SALOP					
Telford (Wrekin)	Carrefour	5,200 (56,000)	10,900 (117,000)	1,000	1973
Telford (Wrekin)	J.Sainsbury	2,600 (28,000)	4,400 (47,000)	900	1973
SOMERSET					
Taunton (Taunton Deans)	Big I	4,600 (50,000)	7,100 (76,000)	650	Planned
Yeovil (Yeovil)	Tesco	2,900 (31,000)	4,600 (50,000)	Shared	1978
SOUTH YORKSHIRE					
Carcroft (Donacaster)	Asda	3,000 (32,000)	4,800 (52,000)	320	1974
Dinnington (Rotherham)	Asda	-	-	-	Planned
Rotherham, Eastwood (Rotherham)	Asda	3,200 (34,000)	5,600 (60,000)	500	1969
Sheffield Sheaf Valley (Sheffield City)	Not Available	4,000 (43,000)	6,000 (65,000)	527	1976
Sheffield, Chapeltown (Sheffield City)	Asda	2,800 (30,000)	4,700 (51,000)	400	1976
Sheffield, Handsworth (Sheffield City)	Asda	2,700 (29,000)	5,500 (59,000)	478	1970

Location (District)	Retailer	Net Floorspace Sq.m. (Sq.ft.)	Gross Floorspace Sq.m. (Sq.ft.)	Car Parking Spaces	Opening Date
STAFFORDSHIRE					
Burslem (Stoke-on-Trent)	Co-op (North Midland Society)	2,800 (30,000)	3,400 (37,000)	450	1973
Hanley (Stoke-on-Trent)	Tesco	5,600 (60,000)	7,600 (82,000)	500	1977
Longton (Stoke-on Trent)	Co-op (North Midland Society)	3,100 (33,000)	4,100 (44,000)	-	Planned
Newcastle-Under-Lyme (Newcastle-under-Lyme)	Co-op (North Midland Society	2,800 (30,000)	4,600 (50,000)	500	1973
Stafford (Stafford)	Tesco	2,600 (28,000)	4,500 (48,000)	400	Planned
Talke (Stoke-on-Trent City)	Co-op (North Midland Society)	6,500 (70,000)	8,000 (86,000)	1,000	1975
Tame Valley Wilnecote (Tamworth)	Co-op (Tamworth Society)	3,300 (35,000)	4,600 (50,000)	700	Planned
SUFFOLK					
Ipswich, Boss Hall (Babergh)	Co-op (Ipswich Society)	2,800 (30,000)	4,900 (53,000)	603	1977
Lowestoft (Waveney)	Fine Fare	4,200 (45,000)	5,900 (64,000)	600	Planned
SURREY					
Woking (Woking)	Fine Fare	3,100 (33,000)	5,600 (60,000)	1,000	1977
TYNE AND WEAR					
Killingworth (North Tyneside)	Woolco	6,300 (68,000)	9,800 (105,000)	1,030	1970

Location (District)	Retailer	Net Floorspace Sq.m. (Sq.ft.)	Gross Floorspace Sq.m. (Sq.ft.)	Car Parking Spaces	Opening Date
TYNE AND WEAR (Contd.)					
North Shields (North Tyneside)	Presto	3,900 (42,000)	5,600 (60,000)	Shared	1978
Washington (Sunderland)	Presto	2,600 (28,000)	3,400 (37,000)	Shared	1978
Washington (Sunderland)	SavaCentre	6,500 (70,000)	15,100 (163,000)	1,300	1977
Washington (Sunderland)	Woolco	6,300 (68,000)	10,400 (112,000)	3,000	1973
WARWICKSHIRE					
Bedworth (Nuneaton)	Tesco	3,300 (35,000)	4,800) (52,000)	450	Planned
Leamington Spa (Warwick)	Asda	3,300 (35,000)	5,200 (56,000)	624	Planned
WEST MIDLANDS					
Aston (Birmingham City)	Asda	4,600 (50,000)	7,200 (78,000)	706	1979
Birmingham (Birmingham City)	Not Available	-	8,700 (94,000)	800	Planned
Birmingham, Edgbaston (Birmingham City)	Tesco	4,600 (50,000)	6,300 (68,000)	-	1979
Birmingham, Small Heath (Birmingham City)	Co-op (Birmingham Society)	3,900 (42,000)	5,600 (60,000)	500	Planned
Brierly Hill (Dudley)	Asda	3,300 (36,000)	5,400 (58,000)	510	1978
Coventry (Coventry City)	Asda	3,500 (38,000)	5,900 (64,000)	659	Planned
Coventry (Coventry City)	J.Sainsbury	2,500 (27,000)	5,300 (57,000)	400	1977

Location (District)	Retailer	Net Floorspace Sq.m. (Sq.ft.)	Gross Floorspace Sq.m. (Sq.ft.)	Car Parking Spaces	Opening Date
WEST MIDLANDS (Contd.)					
Coventry (Covntry City)	Tesco	3,700 (40,000)	5,600 (60,000)	500	Planned
Darlaston (Walsall)	Asda	3,500 (38,000)	5,600 (60,000)	270	1978
Minworth (Birmingham City)	Carrefour	6,500 (70,000)	13,700 (148,000)	1,300	1977
Oldbury (Sandwell)	SavaCentre	5,600 (60,000)	12,100 (130,000)	1,000	Planned
Smethwick (Sandwell)	Co-op (Birmingham Society)	-	4,600 (50,000)	-	Planned
WEST SUSSEX					
Worthing (Worthing)	Tesco	2,600 (28,000)	4,400 (47,000)	300	Planned
WEST YORKSHIRE					
Bradford (Bradford City)	Wm.Morrison Supermarkets	3,300 (36,000)	4,600 (50,000)	452	1976
Bradford (Bradford City)	Tesco	5,600 (60,000)	7,400 (80,000)	450	Planned
Huddersfield (Kirklees)	Hillards	3,300 (35,000)	4,800 (52,000)	450	1979
Huddersfield Birkby (Kirklees)	Asda	3,600 (39,000)	7,400 (80,000)	600	1980
Hunslet (Leeds City)	Wm. Morrison Supermarkets	3,400 (37,000)	4,900 (53,000)	-	1976
Leeds (Leeds City)	Big I	-	5,700 (61,000)	-	Planned
Leeds (Leeds City)	Wm. Morrison Supermarkets	3,300 (36,000)	4,600 (50,000)	146	1972

Location (District)	Retailer	Net Floorspace Sq.m. (Sq.ft.)	Gross Floorspace Sq.m. (Sq.ft.)	Car Parking Spaces	Opening Date
WEST YORKSHIRE (Contd.)					
Leeds, Meanwood (Leeds City)	Tesco	3,000 (32,000)	4,800 (52,000)	400	Planned
Leeds, Middleton (Leeds City)	Tesco	3,700 (40,000)	5,600 (60,000)	-	Planned
Pudsey (Leeds City)	Asda	4,200 (45,000)	8,300 (89,000)	615	1969
Wetherby (Leeds City)	Co-op (Harrogate Soc.)	2,800 (30,000)	3,900 (42,000)	150	1978
WILTSHIRE					
Swindon (Thamesdown)	Carrefour	4,000 (43,000)	6,500 (70,000)	-	Planned
Trowbridge (West Wiltshire)	Tesco	3,000 (32,000)	4,600 (50,000)	-	Planned
WALES					
CLWYD					
Kinmel Bay (Colwyn)	Asda	3,500 (38,000)	5,100 (55,000)	500	Planned
Wrexham (Wrexham Maelor)	Tesco	2,800 (30,000)	4,600 (50,000)	480	1977
DYFED					
Llanelli (Llanelli)	Tesco	3,700 (40,000)	5,600 (60,000)	440	1978
GWENT					
Cwmbran (Torfaen)	Woolco	6,300 (68,000)	10,900 (117,000)	900	1975
Newport (Newport)	Asda	3,100 (33,000)	5,400 (58,000)	746	1973

Location (District)	Retailer	Net Floorspace Sq.m. (Sq.ft.)	Gross Floorspace Sq.m. (Sq.ft.)	Car Parking Spaces	Opening Date
GWYNEDD					
Llandudno (Aberconwy)	Asda	2,900 (31,000)	4,600 (50,000)	700	1977 (1975)
Bridgend (Ogwr)	Big I	3,400 (37,000)	5,500 (59,000)	750	Planned
Bridgend, Pyle (Ogwr)	Co-op (Co-operative Retail Services)	3,100 (33,000)	3,700 (40,000)	400	1973
Caerphilly (Rhymney Valley)	Carrefour	5,100 (55,000)	10,900 (117,000)	1,100	1972
Llantrisant (Taff Ely)	Tesco	3,300 (35,000)	5,000 (54,000)	500	1979
Merthyr Tydfil (Merthyr Tydfil)	Asda	3,200 (34,000)	4,900 (53,000)	540	1977
SOUTH GLAMORGAN					
Barry (Vale of Glamorgan)	Presto	2,600 (28,000)	3,300 (35,000)	280	1971
Cardiff (Cardiff City)	Co-op (Co-operative Retail Services)	4,200 (45,000)	7,000 (75,000)	500	1973
Cardiff (Cardiff City)	Tesco	3,000 (32,000)	4,600 (50,000)	-	Planned
WEST GLAMORGAN					
Neath (Neath)	Tesco	4,000 (43,000)	5,600 (60,000)	Shared	1978
Swansea (Swansea City)	Asda	3,300 (36,000)	5,200 (56,000)	430	Planned
SCOTLAND					
CENTRAL					
Falkirk (Falkirk)	Fine Fare	4,100 (44,000)	5,600 (60,000)	365	1978

Location (District)	Retailer	Net Floorspace Sq.m. (Sq.ft.)	Gross Floorspace Sq.m. (Sq.ft.)	Car Parking Spaces	Opening Date
CENTRAL (Contd.)					
Stirling (Stirling)	Fine Fare	3,200 (34,000)	4,600 (50,000)	180	1974
DUMFRIES AND GALLOWAY					
Dumfries (Nithsdale)	Co-op (Dumfries Soc.)	2,600 (28,000)	3,500 (38,000)	150	1976
FIFE					
Dunfermline (Dunfermline)	Fine Fare	3,000 (32,000)	5,000 (54,000)	400	1975
GRAMPIAN					
Aberdeen (Aberdeen City)	Co-op (Northern Aberdeen Soc.)	4,600 (50,000)	6,400 (69,000)	-	1977
Aberdeen, Bridge of Dee (Aberdeen City)	Fine Fare	3,700 (40,000)	5,600 (60,000)	400	1970
Aberdeen, Bridge of Don (Aberdeen City)	Fine Fare	2,900 (31,000)	4,400 (47,000)	210	Planned
Aberdeen, Dyce (Aberdeen City)	Asda	3,900 (42,000)	5,900 (63,000)	600	1976
LOTHIAN					
Edinburgh (Edinburgh City)	Asda	3,600 (39,000)	6,800 (73,000)	528	1972
Edinburgh, Granton (Edinbugh City)	Co-op (St Cuthberts Edinburgh Soc.)	2,800 (30,000)	3,700 (40,000)	-	1979
Livingston (West Lothian)	Co-op (Blackburn Supermarket Ltd.)	2,800 (30,000)	4,100 (44,000)	600	1976

Location (District)	Retailer	Net Floorspace Sq.m. (Sq.ft.)	Gross Floorspace Sq.m. (Sq.ft.)	Car Parking Spaces	Opening Date
LOTHIAN (Contd.)					
Livingston (West Lothian)	Woolco	6,200 (67,000)	10,400 (112,000)	2,000	1976
STRATHCLYDE					
Ayr (Kyle & Carrick)	Tesco	3,100 (33,000)	4,700 (51,000)	-	1974
Bishopbriggs (Glasgow City)	Fine Fare	4,400 (43,000)	5,400 (58,000)	350	Planned
Blantyre (Hamilton)	Asda	3,400 (37,000)	5,600 (60,000)	420	Planned
Clydebank (Clydebank)	Fine Fare	4,300 (46,000)	5,900 (63,000)	500	1978
Coatbridge (Monklands)	Asda	4,000 (43,000)	6,400 (69,000)	460	1976
Cumbernauld (Cumbernauld & Kilsyth)	Wm.Low	2,600 (28,000)	3,900 (42,000)	440	Planned
Cumbernauld (Cumbernauld & Kilsyth)	Woolco	6,000 (65,000)	10,000 (108,000)	950	1974
East Kilbride (East Kilbride)	Fine Fare	2,900 (31,000)	3,700 (40,000)	1,200	1973
Glasgow, Bearsden (Bearsden & Milngavie)	Fine Fare	4,000 (43,000)	7,600 (83,000)	350	1977
Glasgow, Maryhill (Glasgow City)	Co-op (C.W.S. Retail Operations Group)	3,700 (40,000)	5,600 (60,000)	476	Planned
Greenock (Inverclyde)	Tesco	2,800 (30,000)	4,400 (47,000)	430	1977
Irvine (Cunninghame)	Tesco	2,800 (30,000)	4,600 (50,000)	Shared	1975

Location (District)	Retailer	Net Floorspace Sq.m. (Sq.ft.)	Gross Floorspace Sq.m. (Sq.ft.)	Car Parking Spaces	Opening Date
STRATHCLYDE (Contd.)					
Motherwell (Motherwell)	Fine Fare	3,200 (34,000)	5,600 (60,000)	400	1979
Pollock (Glasgow City)	Co-op (C.W.S. Retail Operations Group)	3,100 (33,000)	5,200 (56,000)	1,200	1979
Pollock (Glasgow City)	Presto	2,600 (28,000)	3,700 (40,000)	Shared	1979
Pollock (Glasgow City)	Tesco	5,100 (55,000)	7,400 (80,000)	Shared	1979
Summerston (Glasgow City)	Asda	3,200 (34,000)	4,900 (53,000)	510	1979
TAYSIDE					
Dundee (Dundee City)	Asda	2,500 (27,000)	4,000 (43,000)	368	1977
Dundee (Dundee City)	Tesco	4,700 (51,000)	6,300 (68,000)	600	1978
NORTHERN IRELAND					
Bangor (North Down)	Stewarts Supermarkets	2,500 (27,000)	4,200 (45,000)	900	1975
Glengormley (Newtonabbey)	Stewarts Supermarkets	2,800 (30,000)	5,200 (56,000)	1,000	1973
Newtonards (Ards)	Stewarts Supermarkets	2,600 (28,000)	4,200 (45,000)	1,400	1976
Newtonards (Ards)	Woolco	4,100 (44,000)	7,200 (78,000)	1,400	1976

APPENDIX B

Socio-economic groups
Classification by socio-economic groups was introduced in 1951 and extensively amended in 1961. The classification aims to bring together people with jobs of similar social and economic status. The classification is applied to the economically active, retired and permanently sick by considering their employment status and occupation.

(1) **Employers and managers in central and local government, industry, commerce etc — large establishments**

1.1 Employers in industry, commerce etc.
Persons who employ others in non-agricultural enterprises employing 25 or more persons.

1.2 Managers in central and local government, industry, commerce, etc.
Persons who generally plan and supervise in non-agricultural enterprises employing 25 or more persons.

(2) **Employers and managers in industry, commerce etc. — small establishments**

2.1 Employers in industry, commerce etc. — small establishments.
As in 1.1 but in establishments employing fewer than 25 persons.

2.2 Managers in industry, commerce etc. — small establishments.
As in 1.2 but in establishments employing fewer than 25 persons.

(3) **Professional workers — self-employed**
Self-employed persons engaged in work normally requiring qualifications of university degree standard.

(4) **Professional workers — employees**
Employees engaged in work normally requiring qualifications of university degree standard.

(5) **Intermediate non-manual workers**

5.1 Ancillary workers and artists
Employees engaged in non-manual occupations ancillary to the professions, not normally requiring qualifications of university degree standard; persons engaged in artistic work and not employing others therein. Self-employed nurses, medical auxiliaries, teachers, work study engineers and technicians are included.

5.2 Foremen and supervisors non-manual
Employees (other than managers) engaged in occupations included in group 6, who formally and immediately supervise others engaged in such occupations.

(6) **Junior non-manual workers**
Employees, not exercising general planning or supervisory powers, engaged in clerical, sales and non-manual communications occupations, excluding those who have additional and formal supervisory functions (these are included in group 5.2).

(7) **Personal service workers**
Employees engaged in service occupations caring for food, drink, clothing and other personal needs.

(8) **Foremen and supervisors — manual**
Employees (other than managers) who formally and immediately supervise others engaged in manual occupations, whether or not themselves engaged in such occupations.

(9) **Skilled manual workers**
Employees engaged in manual occupations which require considerable and specific skills.

(10) **Semi-skilled manual workers**
Employees engaged in manual occupations which require slight but specific skills.

(11) **Unskilled manual workers**
Other employees engaged in manual occupations.

(12) **Own account workers (other than professional)**
Self-employed persons engaged in any trade, personal service or manual occupation not normally requiring training of university degree standard and having no employees other than family workers.

(13) **Farmers — employers and managers**
Persons who own, rent or manage farms, market gardens or forests, employing people other than family workers in the work of the enterprise.

(14) **Farmers — own account**
Persons who own or rent farms, market gardens or forests and having no employees other than family workers.

(15) **Agricultural workers**
Persons engaged in tending crops, animals, game or forests, or operating agricultural or forestry machinery.

(16) **Members of the Armed Forces.**

(17) **Inadequately described and not stated occupations.**

SEG Standard Classification System

APPENDIX C

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AB	01	11
	02	12
	03	13
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	06	16
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AC	01	18
	02	19
	03	20
	04	21
	05	22
	06	23
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AD	01	24
	02	25
AE	01	26
AF	01	27
AG	01	28
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	04	31
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AH	01	33
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	06	59
	07	60
	08	61
	09	62
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	11	64
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AK	01	74
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AL	01	79
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	04	82
	05	83
	06	84
AL	07	85
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	09	87
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AM	01	89
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List of Numbered Ennumeration Districts

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	02	113
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	04	115
	05	116
	06	117
	07	118
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AQ	01	163
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	03	165
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	05	167
	06	168
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	08	170
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List of Numbered Ennumeration Districts

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	14	176
	15	177
	16	178
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AR	01	180
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AR	28	207
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	30	209
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	09	320
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	11	322
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AT	01	326
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	05	330	
	06	331	
	07	332	
	08	333	
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	11	336	
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AU	01	342	
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	14	355	
	15	356	
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	18	359	
AV	19	360	
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	21	362	
	22	363	
AW	01	364	*
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	14	385	
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	17	388	
AY	01	389	
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	04	392
	05	393
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	11	399
	12	400
	13	401
	14	402
	15	403
	16	404
	17	405
	18	
AZ	01	406
	02	407
	03	408
	04	409
	05	410
	06	411
	07	412
	08	413
	09	414
	10	415
	11	416
	12	417
	13	418
	14	419
	15	420
	16	421
	17	422
	18	423

BA	01	424
	02	425
	03	426
	04	427
	05	428
	06	429
	07	430
	08	431
	09	432
	10	433
	11	434
	12	435
	13	436
	14	437
	15	438
	16	439
	17	440
	18	441
	19	442
	20	443
	21	444
	22	445
	23	446
	24	447
	25	448
	26	449 *
	27	450 *
	28	451
	29	452
	30	453
BB	01	454
	02	455
	03	456

C-1 (CONTD.)

List of Numbered Ennumeration Districts

BB	04	457
	05	458
	06	459
	07	460
	08	461
	09	462
	10	463
	11	464
	12	465
	13	466
	14	467
	15	468
	16	469
	17	470
	18	471
	19	472
BC	01	473
	02	474
	03	475
	04	476
	05	477
	06	478
	07	479
	08	480
	09	481
	10	482
	11	483
	12	484
	13	485
	14	486
	15	487
	16	
BD	01	488
	02	489
	03	490
	04	491
	05	492
	06	493
	07	494
	08	495
	09	496
	10	494
	11	
BE	01	498
	02	499
	03	500
	04	501
	05	502
	06	503
	07	504
	08	505
	09	506
	10	507
	11	508
	12	509
	13	510
	14	511
	15	512
	16	513
	17	514
	18	515
	19	516
	20	517
	21	518
	22	519

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List of Numbered Ennumeration Districts

BE	23	520
	24	521
	25	522
	26	523
	27	524
	28	525
	29	526
	30	527
	31	528
	32	529
	33	530
	34	531
	35	532
BF	01	533
	02	534
	03	535
	04	536
	05	537
	06	538
	07	539
	08	540
	09	541
	10	542
	11	543
	12	544
	13	545
	14	546
	15	547
	16	548
	17	549
	18	550
	19	551
	20	552
BF	21	553
	22	554
	23	555
	24	556
	25	557
BG	01	558
	02	559
	03	560
	04	561
	05	562
	06	563
	07	564
	08	565
	09	566
	10	567
	11	568
	12	569
	13	570
	14	571
	15	572
	16	573
	17	574
	18	575
	19	576
	20	577
	21	578
	22	579 *
	23	580
	24	581
	25	582
	26	583
	27	584
	28	585

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List of Numbered Ennumeration Districts

BJ	13	652
	14	653
	15	654
	16	655
	17	656
	18	657
	19	658
	20	659
	21	660
	22	661
	23	662
	24	663
	25	664
	26	665
	28	667
	29	668
	30	669
	31	670
	32	671
	33	672
	34	673
	35	674
BK	01	675
	02	676
	03	677
	04	678
	05	679
	06	680
	07	681
	08	682
	09	683
	10	684
BK	11	685
	12	686
	13	
	14	687
	15	
	16	
BL	01	688
	02	689
	03	690
	04	691
	05	692
	06	692
	07	693
	08	694
	09	695
	10	696
	11	697
	12	698
	13	699
	14	700
	15	701
	16	702
	17	703
	18	704
	19	705
	20	706
	21	707
	22	708
	23	709
	24	710
	25	711
	26	712
	27	

C-1 (CONTD.)

Lists of Numbered Ennumeration Districts

BG	29	586
	30	587
	31	588
	32	589
	33	590
	34	591
	35	592
	36	593
	37	594
	38	595
	39	596
	40	597
	41	598
	42	599
BH	01	600
	02	601
	03	602
	04	603
	05	604
	06	605
	07	606
	08	607
	09	608
	10	609
	11	610
	12	611
	13	612
	14	613
	15	614
	16	615
	17	616
	18	617
	19	618
	20	619
	21	620
	22	621
	23	622
	24	623
	25	624
	26	625
	27	626
	28	627
	29	628
	30	629
	31	630
	32	631
	33	632
	34	633
	35	634
	36	635
	37	636
	38	637
	39	638
	40	639
BJ	01	640
	02	641
	03	642
	04	643
	05	644
	06	645
	07	646
	08	647
	09	648
	10	649
	11	650
	12	651

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List of Numbered Ennumeration Districts

BM	01	713
	02	714
	03	715
	04	716
	05	717
	06	718
	07	719
	08	720
	09	721
	10	722
	11	723 *
	12	724
	13	725
	14	726
	15	727
	16	728
	17	729
	18	730
	19	731
	20	732
	21	733
	22	734
	23	735
	24	736
	25	737
	26	738
	27	739
	28	740
	29	741
	30	742
	31	743
	32	744
	33	745
	34	746
BM	35	
	36	
BN	01	747
	02	748
	03	749
	04	750
	05	751
	06	752
	07	753
	08	754
	09	755
	10	756
	11	757
	12	758
	13	759
	14	760
	15	761
	16	762
	17	763
	18	764
	19	765
	20	
BP	01	766
	02	767
	03	768
	04	769
	05	770
	06	771
	07	772
	08	773
	09	774
	10	775

C-1 (CONTD.)

List of Numbered Ennumeration Districts

BQ	01	776
	02	777
	03	778
	04	779
	05	780
	06	781
	07	782
	08	783
	09	784
	10	785
	11	786
	12	787
	13	788
	14	789
	15	790
	16	791
	17	792
	18	793
	19	794
	20	795
	21	796
	22	797
	23	798
	24	799
	25	800
	26	801
	27	802
	28	803
	29	804
	30	805
	31	806
BR	01	807
	02	808
BR	03	809
	04	810
	05	811
	06	812
	07	813
	08	814
	09	815
	10	816
	11	817
	12	818
	13	819
	14	820
	15	821
	16	822
	17	823
	18	824
	19	825
	20	826
	21	827
	22	828
	23	829
	24	830
	25	831
	26	
	27	
	28	
	29	
	30	832
BS	01	833
	02	834
	03	835
	04	836
	05	837

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List of Numbered Ennumeration Districts

BS	06	838
	07	839
	08	840
	09	841
	10	842
	11	843
	12	844
	13	845
	14	846
	15	847
	16	848
	17	849
	18	850
	19	851
	20	852
	21	853
BT	01	854
	02	855
	03	856
	04	857
	05	858
	06	859
	07	
BU	01	860
	02	861
	03	862
	04	863
	05	864
	06	865
	07	866
	08	867
	09	868
BU	10	869
	11	870
	12	871
	13	872 *
	14	873
	15	874
	16	875
	17	876
	18	877
	19	878
	20	879
	21	880
	22	881
	23	882
	24	883
	25	884
	26	885
	27	886
	28	887
	29	888
	30	889
	31	890
	32	891 *
	33	892
	34	893
	35	894
	36	895
	37	896
	38	897
	39	898
	40	899
	41	900
	42	901
	43	902

C-1 (CONTD.)

List of Numbered Ennumeration Districts

BU	44	903
	45	904
BW	01	905
	02	906
	03	907
	04	908
	05	909
	06	910
	07	911
	08	912
	09	913
	10	914
	11	915
	12	916
	13	917
	14	918
	15	919
	16	920
	17	921
	18	922
	19	923
	20	924
	21	925
	22	926
	23	927
	24	928
	25	929
	26	930
	27	931
	28	932
	29	933
	30	934
BX	01	935
	02	936
	03	937
	04	938
	05	939
	06	940
	07	941
	08	942
	09	943
	10	944
	11	945
	12	946
	13	947
	14	948
	15	949
	16	950
	17	951
	18	952
	19	953
	20	954
	21	955
	22	956
	23	957
	24	958
	25	959
	26	960
	27	961
	28	962
	29	963
	30	
BY	01	964
	02	965
	03	966

C-1 (CONTD.)

List of Numbered Ennumeration Districts

BY	04	967	BZ	12	1000
	05	968		13	1001
	06	969		14	1002
	07	970		15	1003
	08	971		16	1004
	09	972		17	1005
	10	973		18	1006
	11	974		19	1007
	12	975		20	1008
	13	976		21	1009
	14	977		22	
	15	977			
	16	979	CA	01	1010
	17	980		02	1011
	18	981		03	1012
	19	982		04	1013
	20	983		05	1014
	21	984		06	1015
	22	985		07	1016
	23	986		08	1017
	24	987		09	1018
	25	988		10	1019
				11	1020
BZ	01	989		12	1021
	02	990		13	1022
	03	991		14	1023
	04	992		15	1024
	05	993		16	
	06	994			
	07	995	CB	01	1025
	08	996		02	1026
	09	997		03	1027
	10	998		04	1028
	11	999		05	1029

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List of Numbered Ennumeration Districts

CB	06	1030
	07	1031
	08	1032
	09	1033
	10	1034
	11	1035
	12	1036
	13	1037
	14	1038
	15	1039
	16	1040
	17	1041
	18	1042
	19	1043
	20	1044
	21	1045
	22	1046
	23	1047
	24	1048
	25	1049
	26	1050
	27	1051
	28	1052
	29	1053
CC	01	1054
	02	1055 *
	03	1056
	04	1057
	05	1058
	06	1059
	07	1060
	08	1061
	09	1062
CC	10	1063
	11	1064
	12	1065
	13	1066
	14	1067
	15	1068
	16	1069
	17	1070
	18	1071
	19	1072
	20	1073
	21	1074
	22	1075
	23	1076
	24	1077
	25	1078
	26	1079
	27	1080
	28	1081
	29	1082
	30	1083
	31	1084
	32	1085
	33	
	34	
CD	01	1086
	02	1087
	03	1088
	04	1089
	05	1090
	06	1091
	07	1092
	08	1093
	09	

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List of Numbered Ennumeration Districts

CE	01	1094
	02	
CF	01	1095
	02	1096
	03	1097
	04	1098
	05	1099
	06	1100
	07	1101
	08	1102
	09	1103
	10	1104
	11	1105
	12	1106
	13	1107
	14	1108
	15	1109
	16	1110
	17	1111
	18	1112
	19	1113
	20	1114
	21	1115
	22	1116
	23	1117
	24	1118
	25	1119
	26	1120
	27	1121
CG	01	1122
	02	1123
	03	1124
CG	04	1225
	05	1126
	06	1127
	07	1128
	08	1129
	09	1130
	10	1131
	11	1132
	12	1133
	13	1134
	14	1135
	15	1136
	16	1137
	17	1138
	18	1139
	19	1140
	20	
	21	
CH	01	1141
	02	1142
	03	1143
	04	1144
	05	1145
	06	1146
	07	1147
	08	1148
	09	1149
	10	1150
	11	1151
	12	1152
	13	1153
	14	1154
	15	1155

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List of Numbered Ennumeration Districts

CH	16	1156
	17	1157
	18	1158
	19	1159
	20	1160
	21	1161
	22	1162
	23	
CJ	01	1163 *
	02	1164
	03	1165
	04	1166
	05	1167
	06	1168
	07	1169
	08	1170
	09	1171
	10	1172
	11	1174
	12	1174
	13	1175
	14	1176
	15	1177
	16	1178
	17	1179
	18	1180
	19	1181
	20	1182
	21	1183
	22	1184
	23	1185
	24	1186
	25	1187
CJ	26	1188
	27	1189
	28	1190
	29	1191
	30	1192
	31	1193
	32	1194
	33	1195
CK	01	1196
	02	1197
	03	1198
	04	1199
	05	1200
	06	1201
	07	1202
	08	1203
	09	1204
	10	1205
	11	1206
	12	1207
	13	1208
	14	1209
	15	1210
	16	1211
	17	1212
	18	1213
	19	1214
	20	1215
CL	01	1216
	02	

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List of Numbered Ennumeration Districts

CR	01	1282	CS	17	1314
	02	1283		18	1315
	03	1284		19	1316
	04	1285		20	1317
	05	1286		21	1318
	06	1287		22	1319
	07	1288			
	08	1289	CT	01	1320
	09	1290		02	1321
	10	1291		03	1322
	11	1292		04	1323 *
	12	1293		05	1324
	13	1294		06	1325
	14	1295		07	1326
	15	1296		08	1327
	16	1297		09	1328
	17			10	1329
				11	1330
CS	01	1298		12	1331
	02	1299		13	1332
	03	1300		14	1333
	04	1301		15	1334
	05	1302		16	1335
	06	1303		17	1336
	07	1304		18	1337
	08	1305		19	1338
	09	1306		20	1339
	10	1307		21	1340
	11	1308		22	1341
	12	1309		23	1342
	13	1310		24	1343
	14	1311		25	1344
	15	1312		26	1345
	16	1313		27	1346

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List of Numbered Ennumeration Districts

CM	01	1217
	02	1218 *
	03	1219
	04	1220
	05	1221
	06	1222
	07	1223
	08	1224
	09	1225
	10	1226
	11	1227
	12	1228
	13	1229
	14	1230
	15	1231
	16	1232
	17	1233
	18	1234
	19	1235
	20	1236
	21	1237
	22	1238
	23	1239
	24	1240
	25	1241
	26	1242
CN	01	1243
	02	1244 *
	03	1245
	04	1246
CP	01	1247
	02	1248
CP	03	1249
	04	1250
	05	1251
	06	1252
	07	1253
	08	1254
	09	1255
	10	1256
	11	1257
	12	1258
	13	1259
	14	1260
CQ	01	1261
	02	1262
	03	1263
	04	1264
	05	1265
	06	1266
	07	1267
	08	1268
	09	1269
	10	1270
	11	1271
	12	1272
	13	1273
	14	1274
	15	1275
	16	1276
	17	1277
	18	1278
	19	1279
	20	1280
	21	1281

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List of Numbered Ennumeration Districts

CT	28	1347
	29	1348
	30	1349
	31	1350
	32	1351
	33	1352
	34	1353
	35	1354
	36	1355
	37	1356
	38	1357
	39	1358
	40	1359
	41	1360
	42	1361
CU	01	1362
	02	1363
	03	1364
	04	1365
	05	1366
	06	1367
	07	1368
	08	1369
	09	1370
	10	1371
	11	1372
	12	1373
	13	1374
	14	1375
	15	1376
	16	1377
	17	1378
	18	1379
CU	19	1380
	20	1381
	21	1382
	22	1383
	23	1384
	24	1385
	25	1386
	26	1387
	27	
	28	
	29	
CW	01	1388
	02	1389
	03	1390
	04	1391
	05	1392
	06	1393
	07	1394
	08	1395
	09	1396
	10	1397
	11	1398
	12	1399
	13	1400
	14	1401
	15	1402
	16	1403
	17	1404
	18	1405
	19	1406
	20	1407
	21	1408
	22	1409

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List of Numbered Ennumeration Districts

CW	23	1410
	24	1411
	25	14112
	26	1413
	27	1414
	28	1415
	29	1416
	30	1417
	31	1418
CX	01	1419
	02	1420
	03	1421
	04	1422
	05	1423
	06	1424 *
	07	1425
	08	1426
	09	1427
	10	1428
	11	1429
	12	1430
	13	1431
	14	1432
	15	1433
	16	1434
	17	1435
	18	1436
	19	1437
	20	1438
CY	01	1439
	02	1440
	03	1441
	04	1442
	05	1443
	06	1444
	07	1445
	08	1446
	09	1447
	10	1448
	11	1449
	12	1450
	13	1451
	14	1452
	15	1453
	16	1454
	17	1455
	18	1456
	19	1457
	20	1458
	21	1459
	22	1460
	23	1461
	24	1462
	25	1463
	26	1464
	27	1465
CZ	01	1466
DA	01	1467
DB	01	1468
DC	01	1469

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List of Numbered Ennumeration Districts

DE	01	1470
	02	1471
DF	01	1472
	02	1473
	03	1474
	04	1475
	05	1476
	06	1477
	07	1478
	08	1479
	09	1480
	10	1481
	11	1482
	12	1483
	13	1484
	14	1485
	15	1486
	16	
DG	01	1487
	02	1488
	03	1489
	04	1490
	05	1491
	06	1492
	07	1493
	08	1494
	09	1495
	10	1496
	11	1497
	12	1498
	13	1499
DH	01	1500
	02	1501
	03	1502
	04	1503
	05	1504
	06	1505
	07	1506
	08	1507
	09	1508
	10	1509
	11	1510
	12	1511
	12	1512
	14	1513
	15	1514
	16	1515
	17	1516
	18	1517
	19	1518
	20	1519
	21	1520
	22	1521
	23	1522
	24	1523
	25	1524
	26	1525
	27	1526
DJ	01	1527
DK	01	1528
DL	1529	

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List of Numbered Ennumeration Districts

EDINBURGH DISTRICT : INSTITUTIONAL ENUMERATION DISTRICTS

Institutional Enumeration District	Ed of which Institution forms part	Postcode Unit	Institution
29 AA 11	29 AA 06	EH1 1QN	Carlton Hotel
29 AB 08	29 AB 01	EH1 2DA	Caley Hotel
29 AB 09	29 AB 06	EH1 2HJ	Castle Trades Hotel
29 AB 10	29 AB 04	EH1 2PP	Church of Scotland Assembly Rooms (College)
29 AC 07	29 AC 01	EH2 2EH	King James Hotel
29 AE 02	29 AE 01	EH2 5EH	North British Hotel
29 AH 22	29 AH 07	EH3 5PE	Edinburgh Academy, Dundas House
29 AK 06	29 AK 02	EH3 7SG	Rothesay Hotel
29 AL 11	29 AL 07	EH3 8AP	Lodging House, Grove Street
29 AM 24	29 AM 16	EH3 9EE	Royal Infirmary
29 AM 25	29 AM 16	EH3 9EE	Simpson's Maternity Hospital
29 AM 26	29 AN 03	EH3 9NG	St. Joseph's Old People's home
29 AN 25	29 AN 04	EH4 1QS	Fettes College
29 AP 29	29 AP 26	EH4 2DL	Royal Victoria Hospital
29 AP 30	29 AP 16	EH4 2LE	Western General Hospital
29 AQ 18	29 AQ 07	EH4 3HL	Eurocrest Hotel, Queensferry Rd.
29 AT 17	29 AT 04	EH4 6HT	Cargilfield School
29 AT 18	29 AT 06	EH4 6JR	Dunfermline College
29 AY 18	29 AY 17	EH5 2DG	Northern General Hospital
29 BC 16	29 BC 17	EH6 6TG	Leith Hospital
29 BD 11	29 BD 05	EH6 7LG	Eastern General Hospital
29 BK 13	29 BK 02	EH8 8AX	Queensberry House Hospital
29 BK 15	29 BK 06	EH8 8DP	Veterans Residence
29 BK 16	29 BK 10	EH8 8EW	Elsie Inglis Maternity Hospital
29 BL 27	29 BL 17	EH8 9RR	Deaconess Hospital
29 BM 35	29 BM 20	EH9 1LQ	Sick Children's Hospital
29 BM 36	29 BM 31	EH9 1SH	Longmore Hospital
29 BN 20	29 BN 01	EH9 2HB	Astley Ainslie Hospital
29 BR 26	29 BR 22	EH10 5BJ	St. Denis School
29 BR 27	29 BR 20	EH10 5HE	Royal Edinburgh Hospital
29 BR 28	29 BR 09	EH10 5LF	Craighouse
29 BR 29	29 BR 02	EH10 5RZ	City Hospital
29 BT 07	29 BT 05	EH10 7DR	Princess Margaret Rose Hospital
29 BX 30	29 BX 19	EH11 3LJ	Saughton Prison
29 BZ 22	29 BZ 20	EH12 5ED	Grosvenor Hotel
29 CA 16	29 CA 07	EH12 6TS	Corstorphine Hospital
29 CC 33	29 CC 30	EH12 8TY	St. Margaret's College
29 CC 34	29 CC 01	EH12 8LU	Royal Scot Hotel
29 CD 09	29 CD 07	EH12 9BH	Gogarburn Hospital
29 CE 02	29 CE 01	EH12 0AG	Turnhouse Airport, Terminal Buildings
29 CG 20	29 CG 02	EH13 0PD	Convent of the Good Shepherd
29 CG 21	29 CG 09	EH13 0PR	Redford Barracks
29 CH 23	29 CH 02	EH14 1DW	Sacred Heart Convent
29 CL 02	29 CL 01	EH14 4AP	Riccarton Campus - Heriot-Watt University
29 CR 17	29 CR 01	EH15 2NJ	Leith Nautical College
29 CU 27	29 CU 25	EH16 5BG	Pollock Halls of Residence
29 CU 28	29 CU 11	EH16 5LZ	Royal Blind School
29 CU 29	29 CU 12	EH16 5PH	Edinburgh Women's Hostel
29 DF 16	29 DF 12	EH28 8LQ	Cliftonhall School.

C-2

List of Institutional Ennumeration Districts

APPENDIX D

LOTHIAN REGIONAL COUNCIL

Principal W A Turmeau, BSc,PhD,CEng,FIMechE

Napier College
OF
COMMERCE & TECHNOLOGY

Please reply to

● Colinton Road, Edinburgh, EH10 5DT 031-447 7070

○ Sighthill Court, Edinburgh, EH11 4BN 031-443 6061

Your ref

Our ref

Date

Dear Sir/Madam

The Traffic Impact of Superstores:
Letter of Authorisation

This is to certify that has been employed by Napier College as an interviewer on the above research project.

If there are any queries or problems arising from the survey please do not hesitate to call me at Napier College - telephone number 031-447-7070 Ext. 252.

Yours sincerely

Geoff Hazel

George Hazel BSc MSc CEng MICE MCIT MIHE
Lecturer
Department of Civil Engineering

D-1
Letter of Authorisation given to Interviewer

Owner/Occupier,
20 Victoria Street,
EH1 2HG

Napier College
OF
COMMERCE & TECHNOLOGY

Please reply to
● Colinton Road, Edinburgh, EH10 5DT 031-447 7070
○ Sighthill Court, Edinburgh, EH11 4BN 031-443 6061

Your ref

Our ref

Date

Dear Sir/Madam

The Traffic Impact of Superstores

I am at present a lecturer at Napier College involved in researching the traffic impact of superstores in Edinburgh for a part-time Ph.D. degree.

As you may appreciate these large stores cause parking and road safety problems to their immediate surroundings and can be damaging to the local environment. The research I am engaged in is trying to forecast the level of traffic generated by these superstores so that the local authority and the developer can ensure the optimum siting for the store.

An essential part of the research is relating usage, or non-usage, of these stores with household characteristics and for that I need your help. Your area has been chosen at random from GPO postal codes and an interviewer will be calling on you in the near future with a questionaire and shopping diary. The questionaire will take approximately ten minutes to complete and the shopping diary requires to be filled in for a period of one week. The interviewer will be carrying a letter of authorisation which you can ask to be shown.

The information is strictly confidential and the questionaires/ shopping diaries have no names and addresses attached to them. I do not know the origin of any questionaires; this is of no consequence to my research. There is therefore no way survey details can be traced to a particular house.

The survey, however, is entirely voluntary and you may decline to take part if you so desire. The survey also only applies to car-owning households so if there is no car or van attached to your household tell the interviewer and he/she will pass to the next house.

I thank you in advance for your trouble and hope you will agree to take part in the research.

Yours sincerely

George Hazel BSc MSc CEng MICE MCIT MIHE
Lecturer
Department of Civil Engineering

D-2
Information letter sent to all potential households

APPENDIX E

BEST COPY AVAILABLE

Variable print quality

001	01.00	03.50	020.00	035.00	01.00	05.00	01	1	01	01	01	03	45	18	017	014	018
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E-1

Data File for Area 1 - Moredun

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E-2

Data File for Area 2 - Spottiswoode

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E-3

Data File for Area 3 - Clermiston

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E-4

Data File for Area 4 - Swanston

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E-5

Data File for Area 5 - Waverley

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E-6

Data File for Area 6 - Westburn

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007	01.00	01.00	010.00	010.00	01.00	01.00	03	0	01	01	01	01	024	0000	018	000	008
007	01.00	02.00	028.00	041.00	01.00	02.00	01	1	02	05	02	02	047	0012	012	020	018
007	00.50	00.50	026.50	026.50	00.25	00.25	01	0	01	03	02	04	020	0014	004	010	018
007	01.00	01.50	017.00	022.00	01.00	02.00	01	0	01	03	02	02	024	0000	007	020	008
007	00.50	00.50	015.00	015.00	01.00	01.00	03	0	01	02	01	01	024	0000	018	000	008
007	01.50	01.50	048.00	048.00	01.25	01.25	01	1	01	04	00	03	028	0017	012	011	018
007	00.50	00.50	012.00	012.00	01.00	01.00	01	1	01	03	01	01	024	0000	005	010	008
007	00.00	02.25	000.00	060.00	00.00	09.00	03	1	01	04	02	03	038	0000	009	020	008
007	00.75	00.75	015.40	015.40	01.00	01.00	01	0	01	02	01	01	024	0000	005	010	006
007	00.25	00.25	020.00	020.00	00.25	00.25	01	1	01	02	02	04	023	0017	005	011	008
007	01.50	01.50	035.00	035.00	01.00	01.00	01	1	01	05	01	04	023	0017	004	015	004

E-7

Data File for Area 7 - St Peters

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E-8

Data File for Area 8 - Saughton

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E-9

Data File for Area 9 - Craigleith Hill

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E-10

Data File for Area 10 - Pilton

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E-11

Data for File for Area 11 - Cammo

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012	03.25	06.50	027.00	051.60	01.00	03.00	01	1	01	03	02	04	016	0009	005	010	018
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012	01.00	00.00	020.00	020.00	01.00	01.00	01	1	02	04	02	02	024	0000	002	010	018
012	01.25	01.25	046.00	046.00	01.25	01.25	01	1	02	05	02	05	020	0016	004	020	008
012	01.50	01.50	039.00	039.00	02.00	02.00	01	1	01	03	01	03	034	0024	006	012	006
012	00.75	00.75	034.00	034.00	01.00	01.00	01	1	01	04	02	05	023	0015	004	020	018
012	02.00	05.75	041.00	064.98	02.00	07.00	01	1	01	06	02	05	027	0012	007	040	008
012	01.50	03.50	024.00	044.00	01.00	03.00	01	0	02	03	02	04	036	0024	002	010	018
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012	01.00	01.00	022.00	022.00	01.00	01.00	01	0	01	05	02	02	031	0010	004	020	008
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E-12

Data File for Area 12 - Turnhouse

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E-13

Data File for Area 13 - Leith

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E-14

Data File for Area 14 - Craigleith

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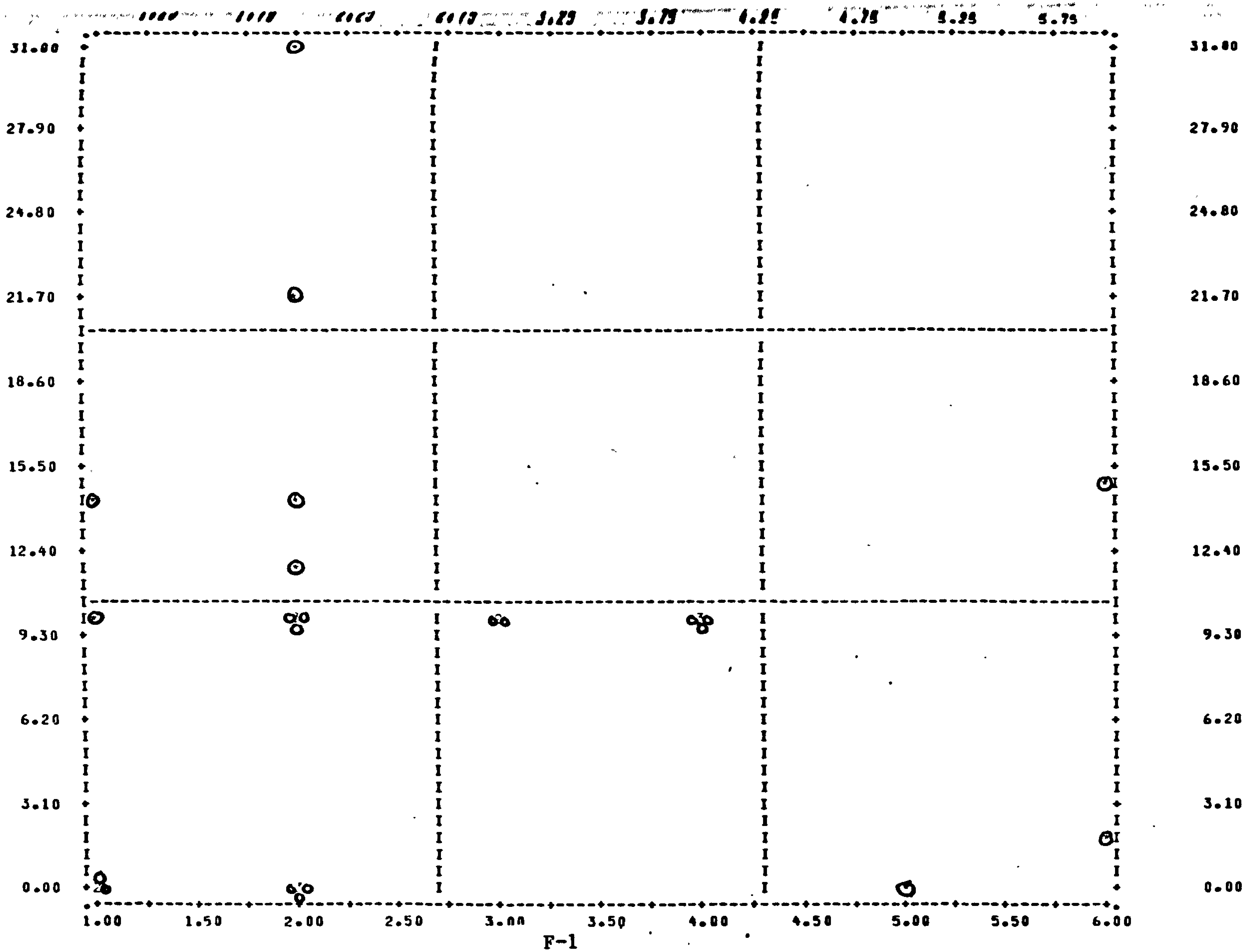
E-15

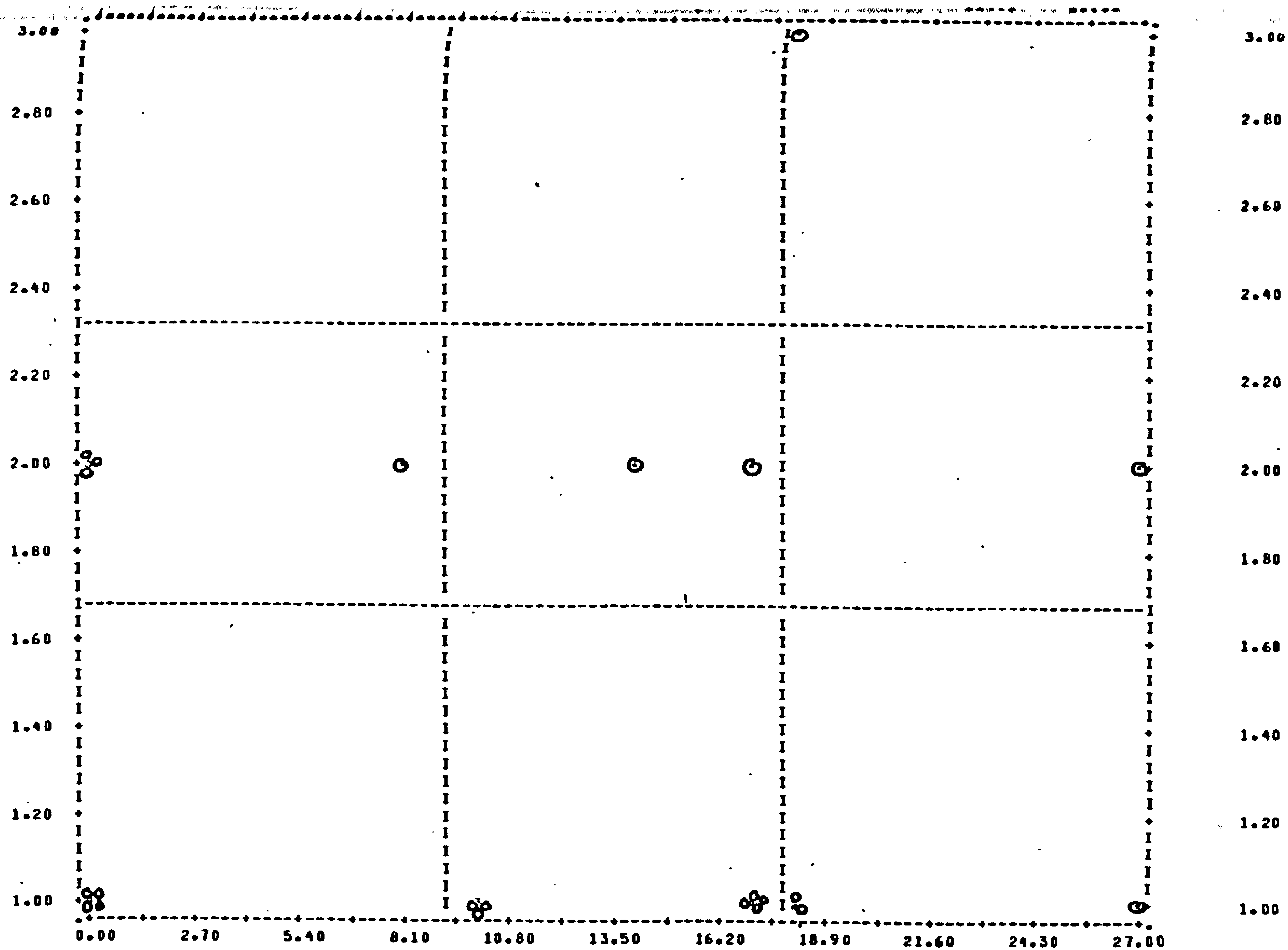
Data File for Area 15 - Easter

APPENDIX F

TEXT BOUND
INTO
THE SPINE

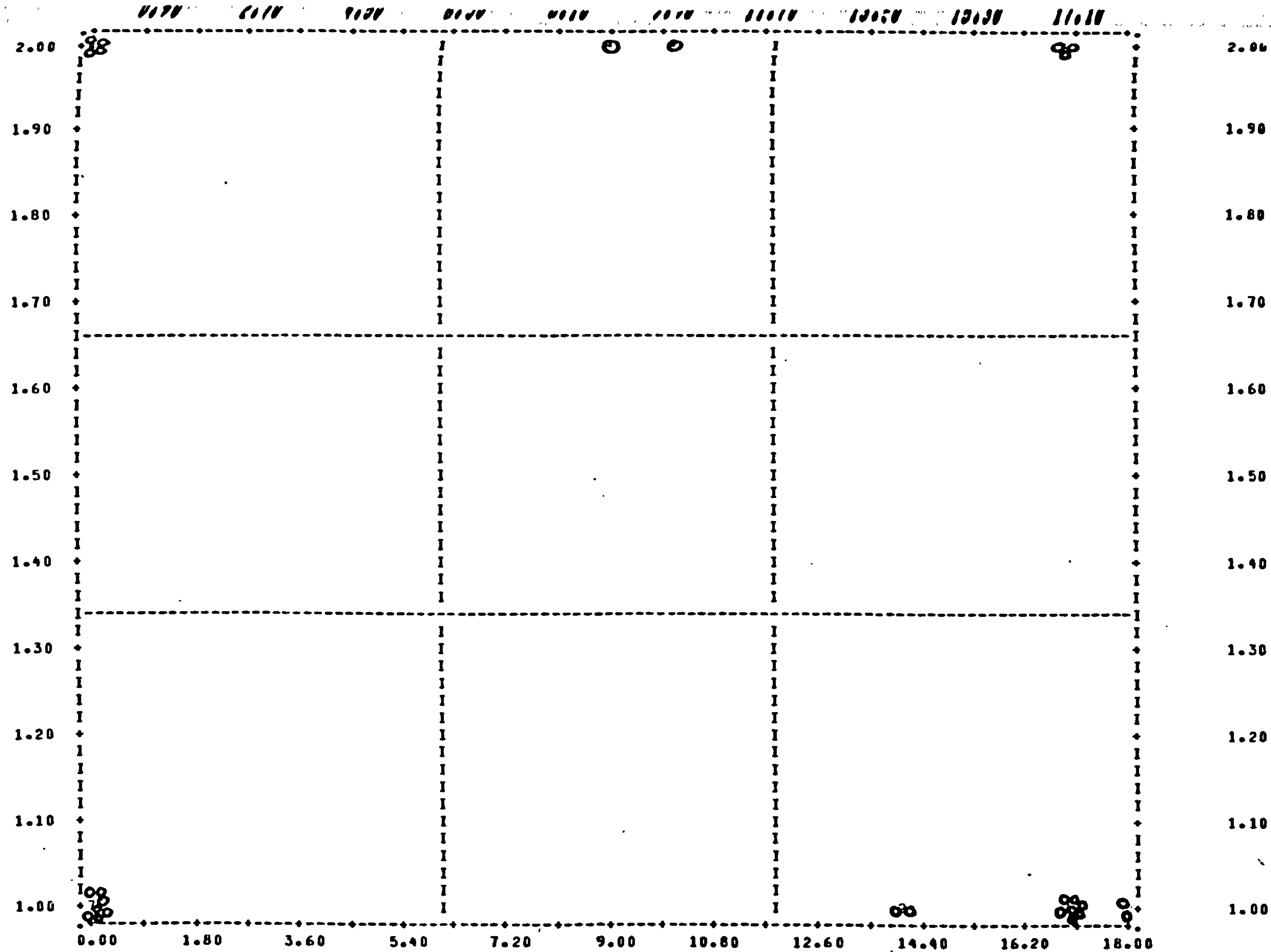


Income (K) v. No. of Half Days Employed (Q) - Area 1 (Moredun)



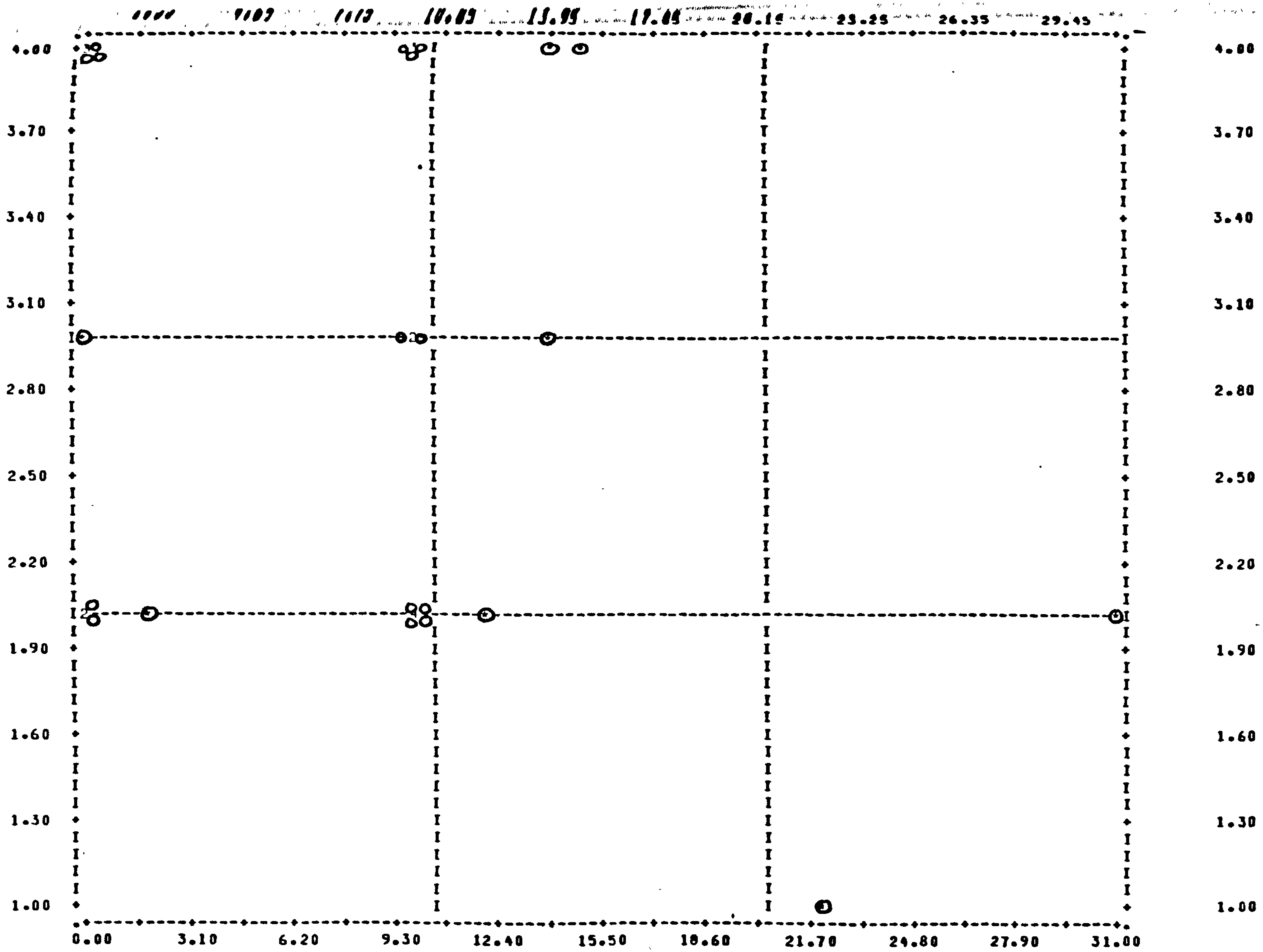
F-2

No. of License Holders (L) v. S.D. of Ages (O) - Area 1 (Moredun)



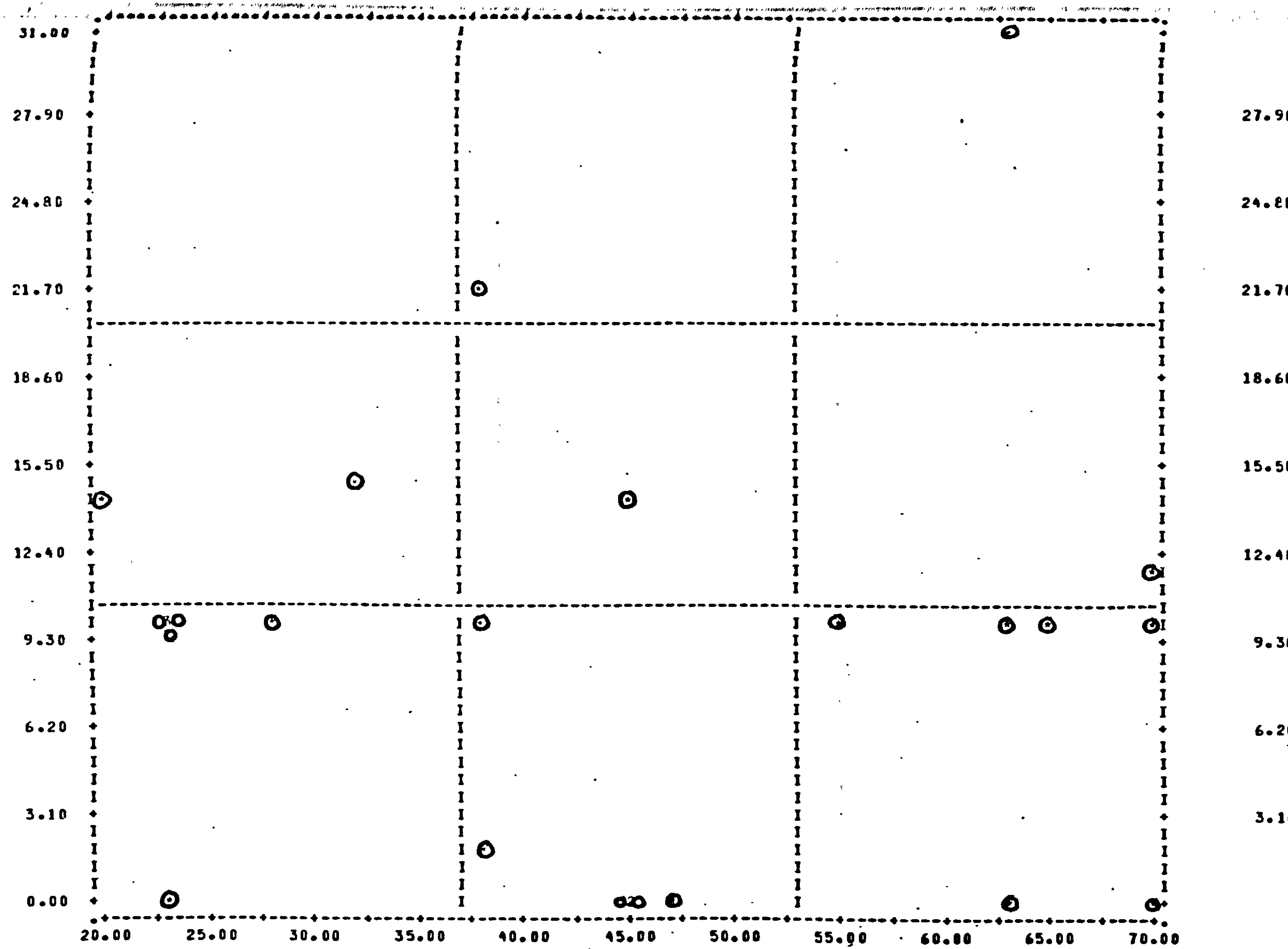
F-3

No. of License Holders (L) v. No. of Half Days Employed (Q) - Area 1 (Moredun)



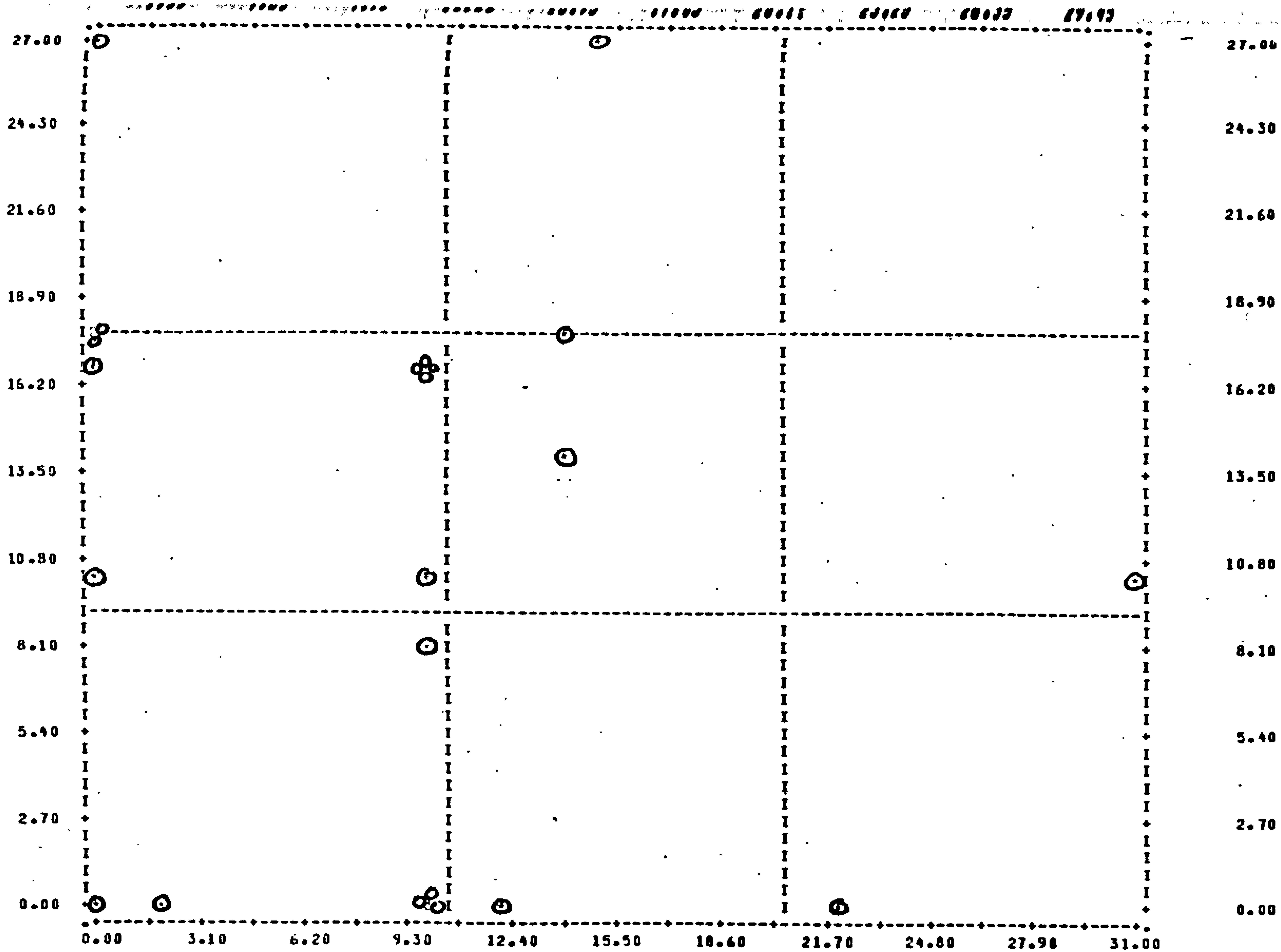
F-4

No. in Household (M) v. No. of Half Days Employed (Q) - Area 1 (Moredun)



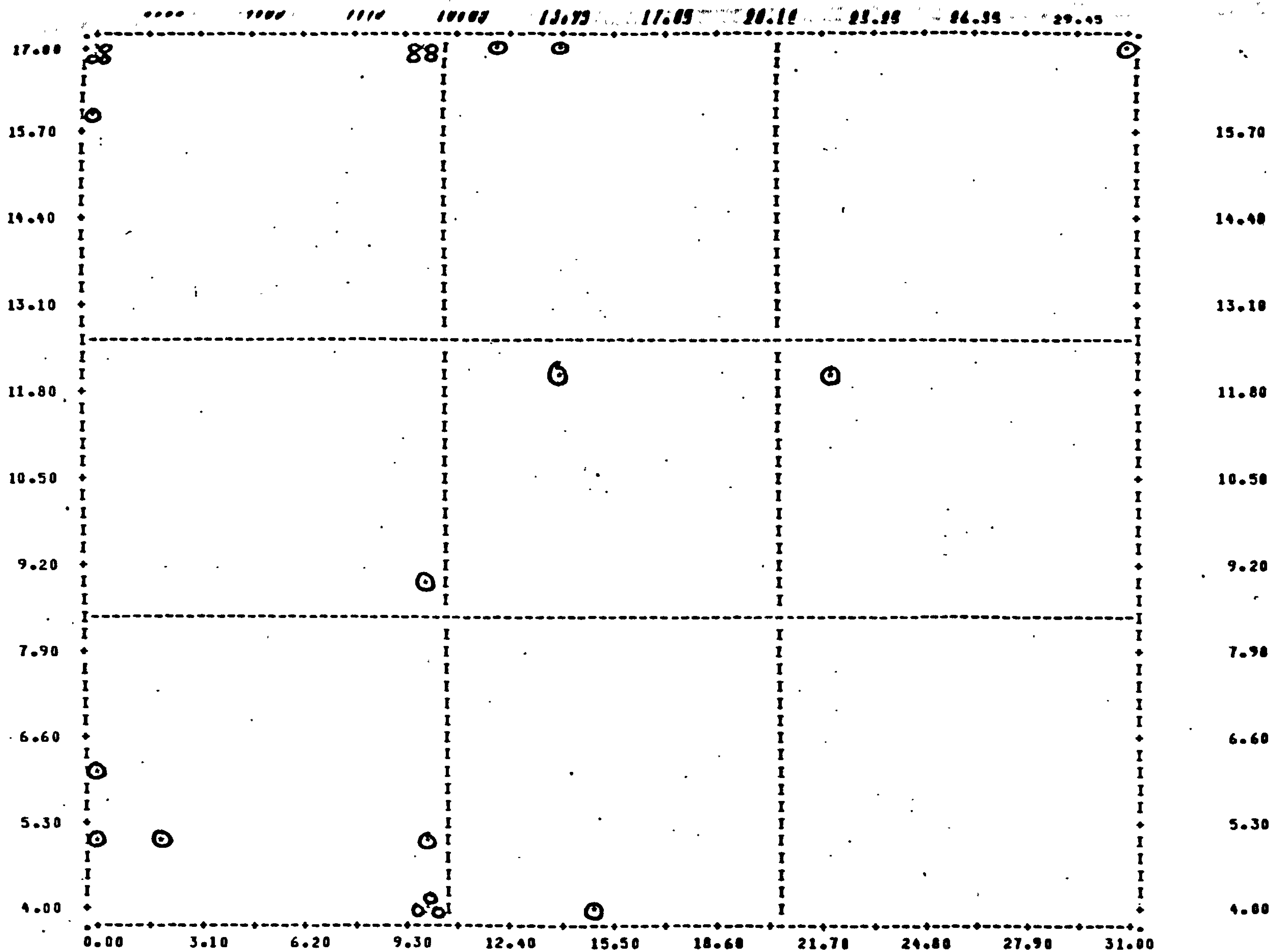
F-5

Mean of Age Structure (N) v. No. of Half Days Employed (Q) - Area 1 (Moredun)



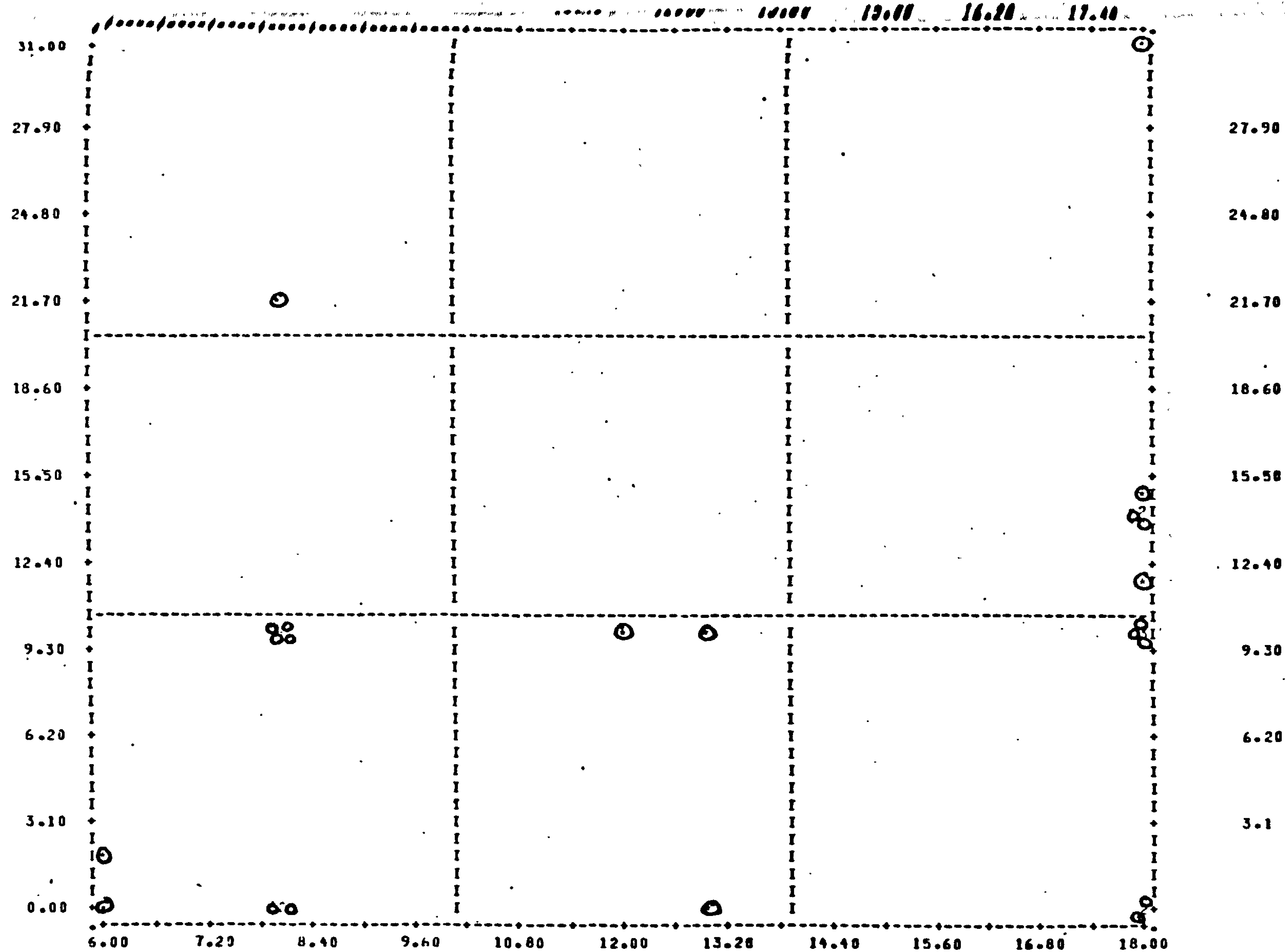
F-6

S.D. of Age Structure (O) v. No. of Half Days Employed (Q) - Area 1 (Moredun)



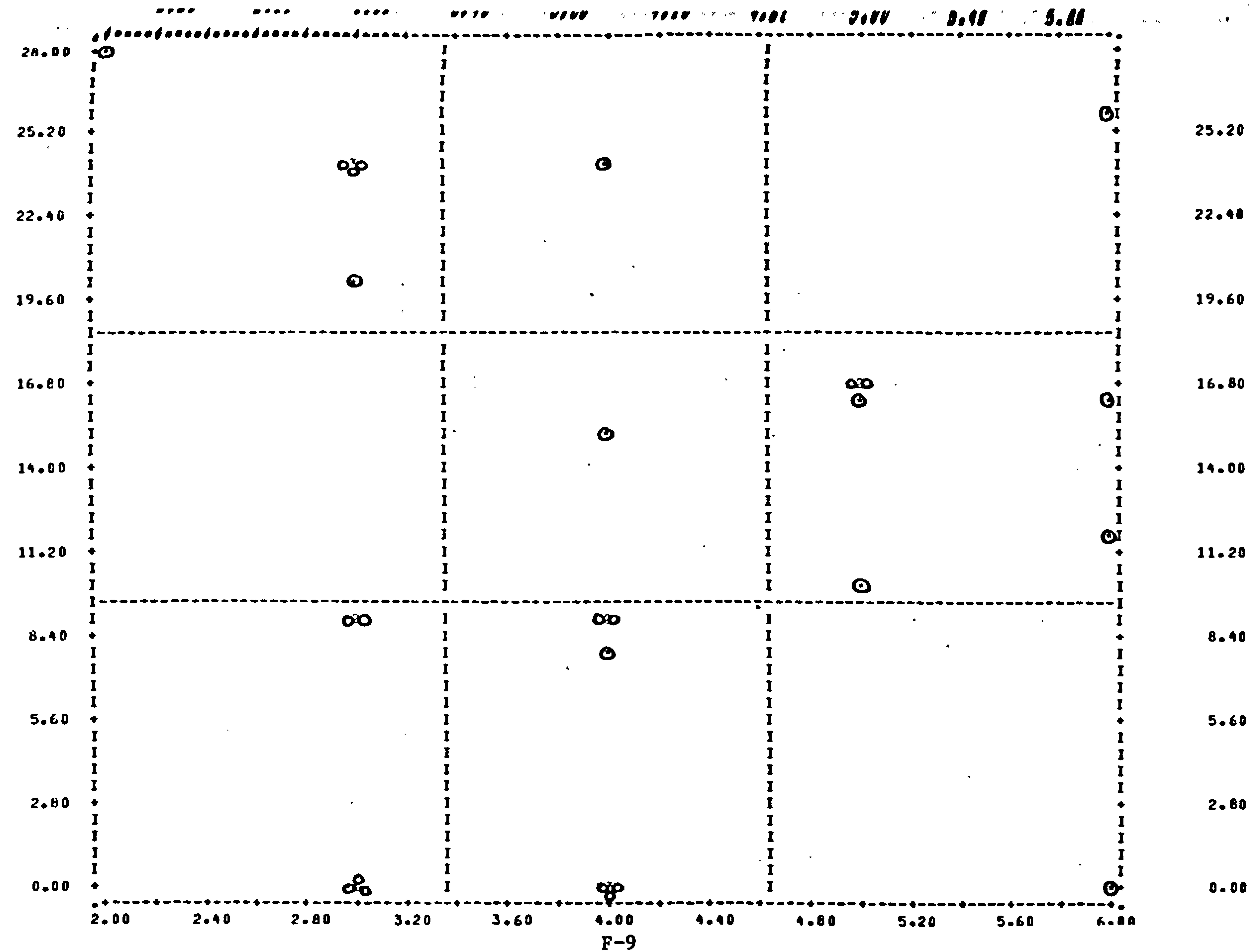
F-7

SEG of Head of Household (P) v. No. of Half Days Employed (Q) - Area 1 (Moredun)

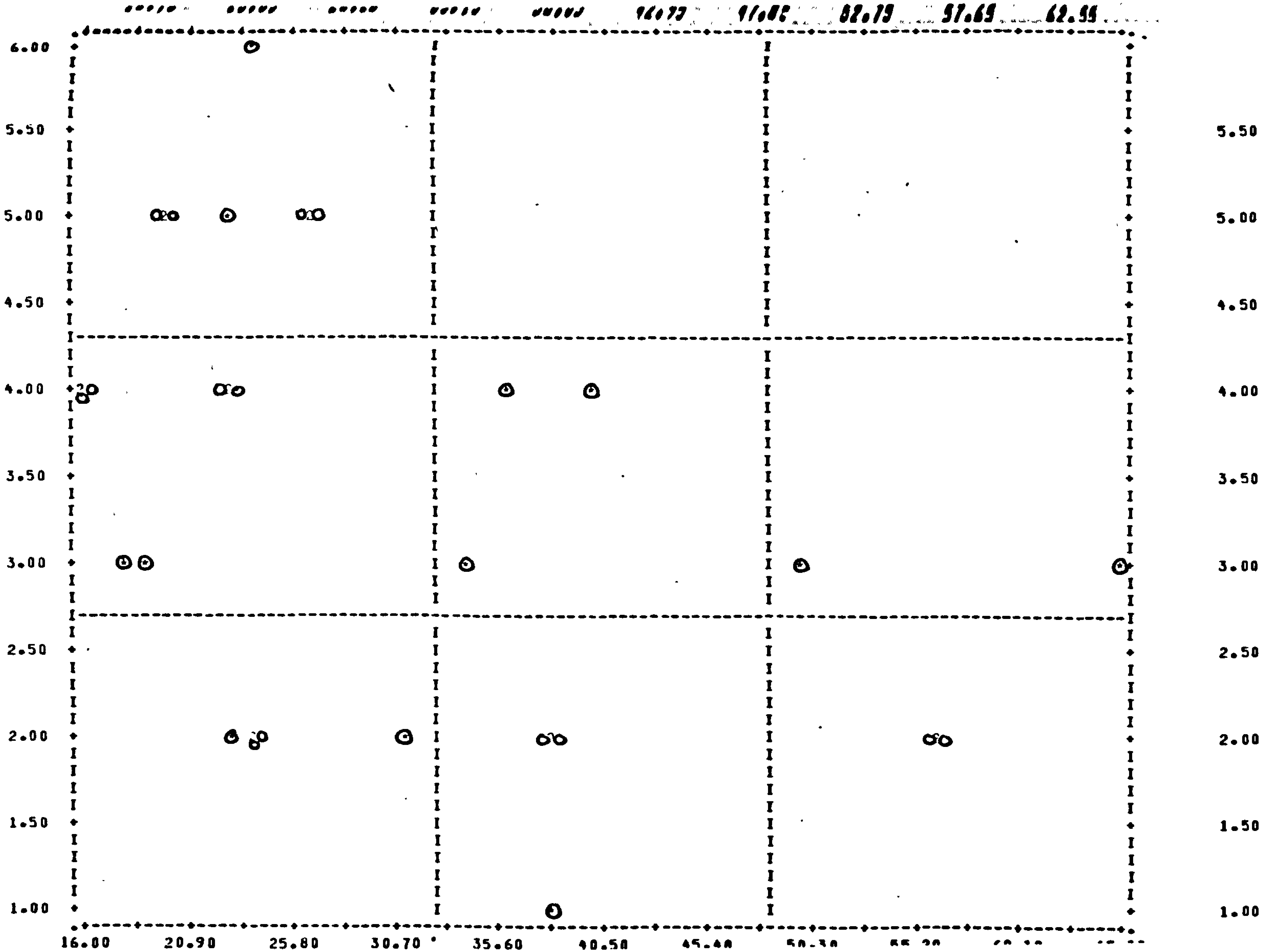


F-8

No. of Half Days Employed (Q) v. Personal Accessibility (R) - Area 1 (Moredun)

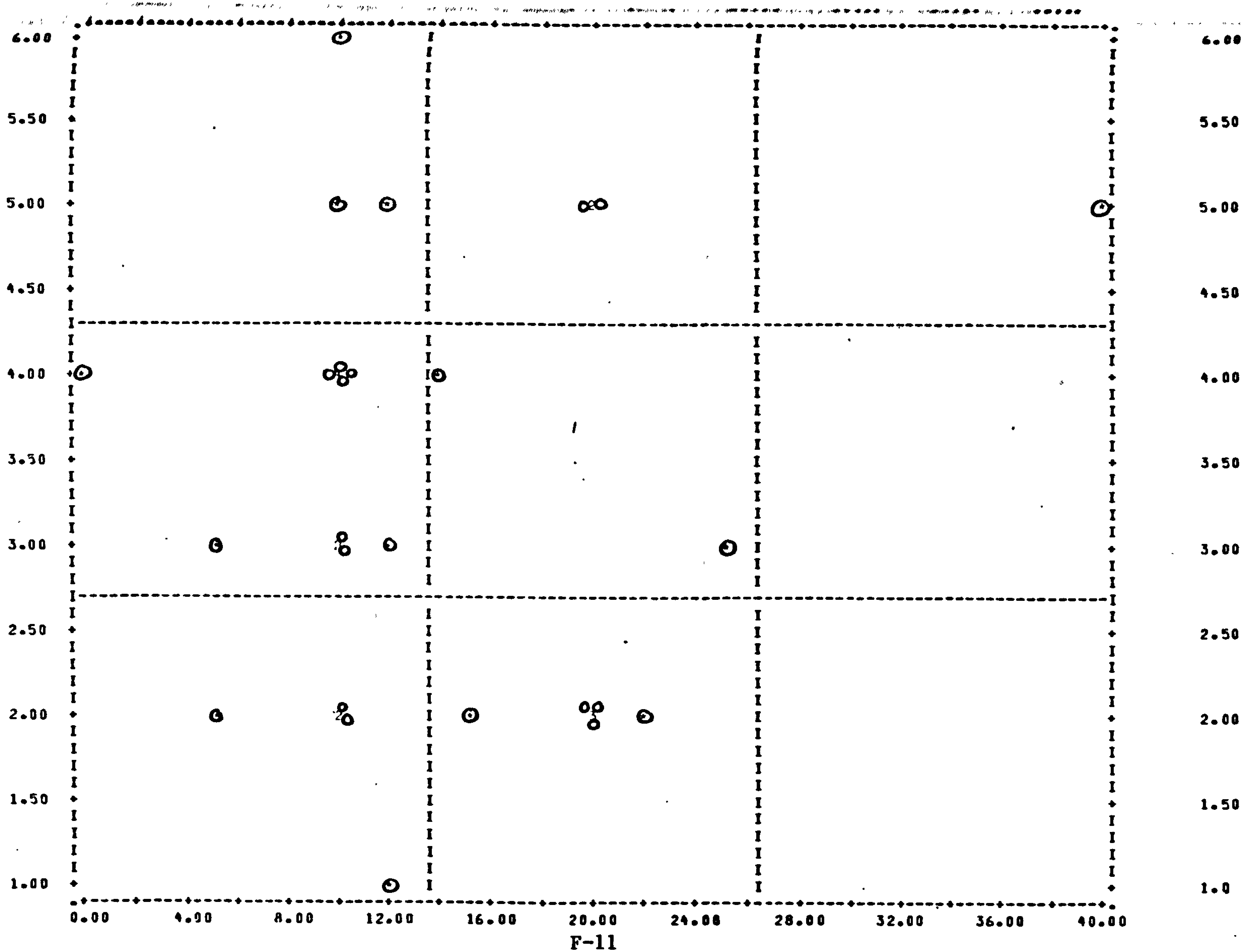


Income (K) v. SD of Ages (O) - Area 12 (Turnhouse)

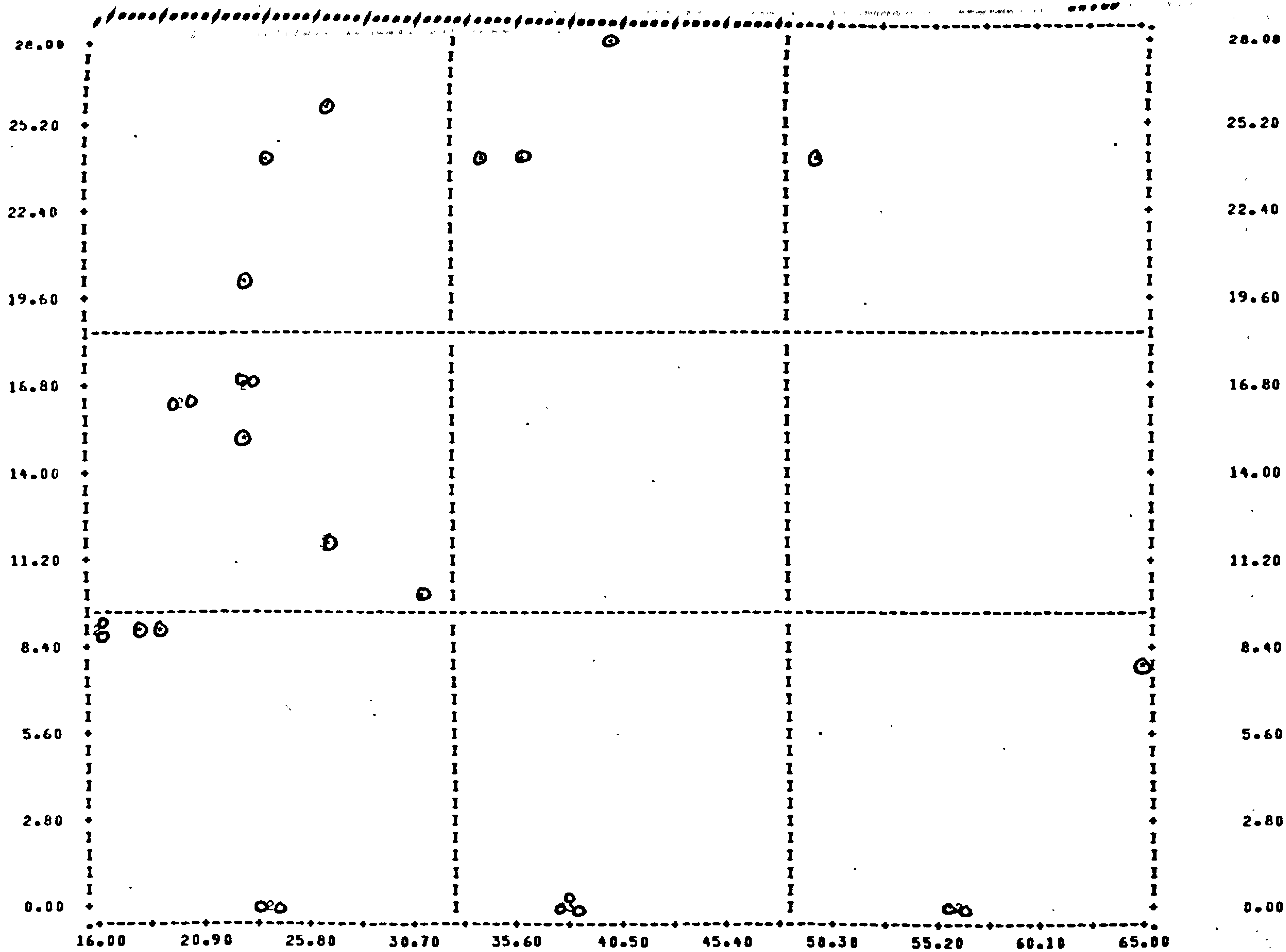


F-10

No. in Household (M) v. Mean Age of Household (N) - Area 12 (Turnhouse)

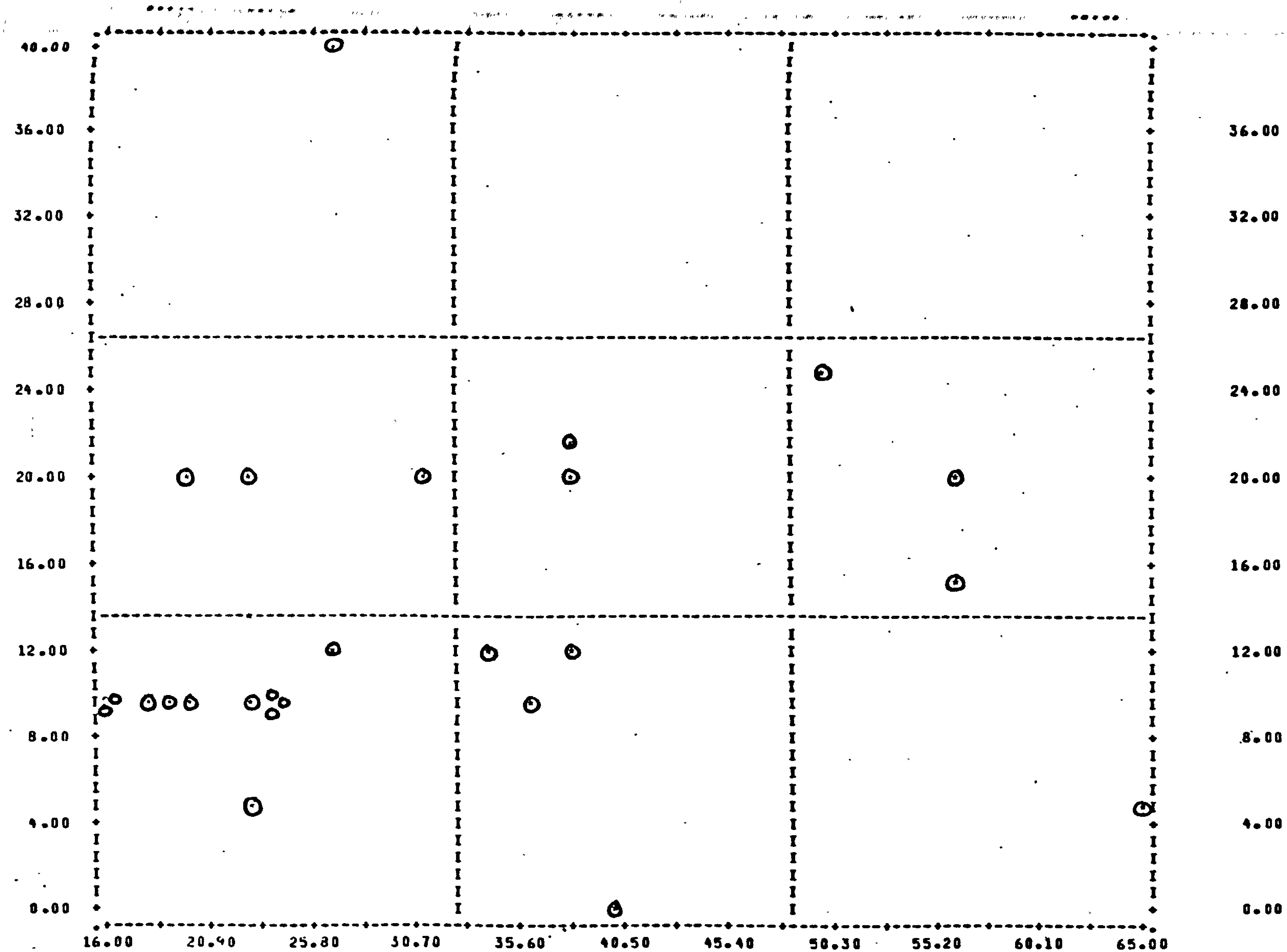


No. in Household (M) v. No. of Half Days Employed (Q) - Area 12 (Turnhouse)



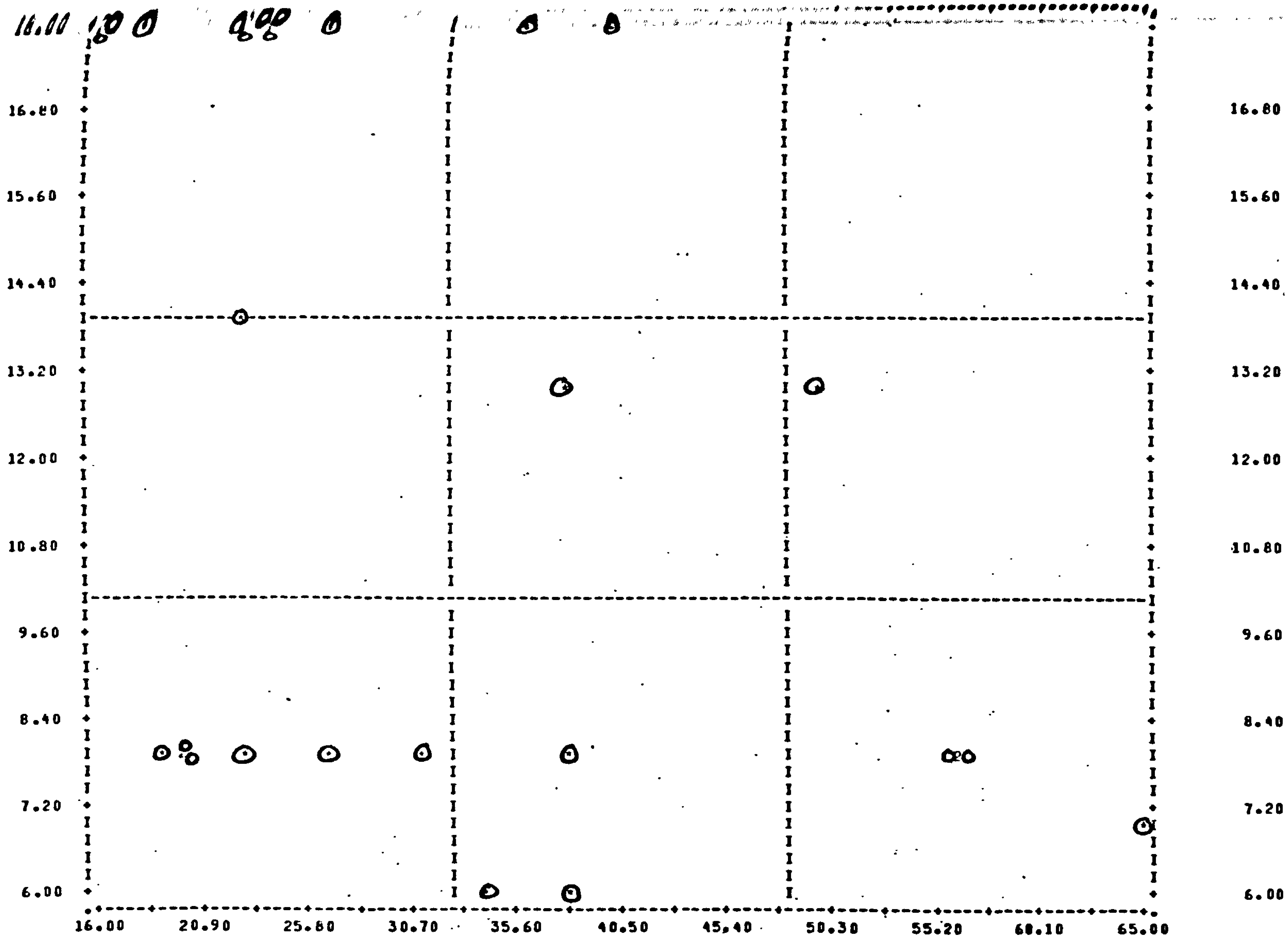
F-12

Means of Age Structure (N) v. SD of Age Structure (O) - Area 12 (Turnhouse)



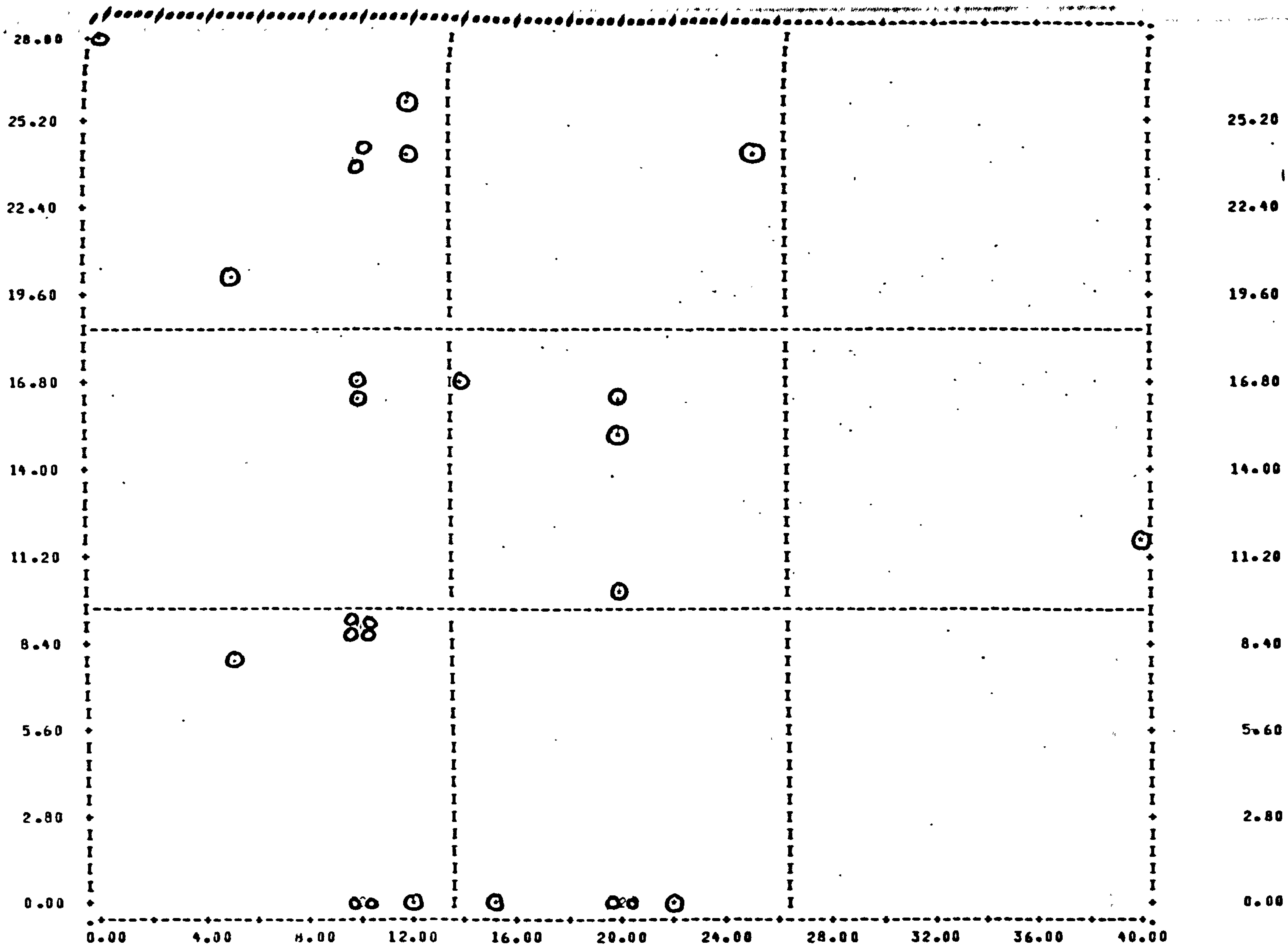
F-13

Mean of Age Structure (N) v. No. of Half Days Employed (Q) - Area 12 (Turnhouse)



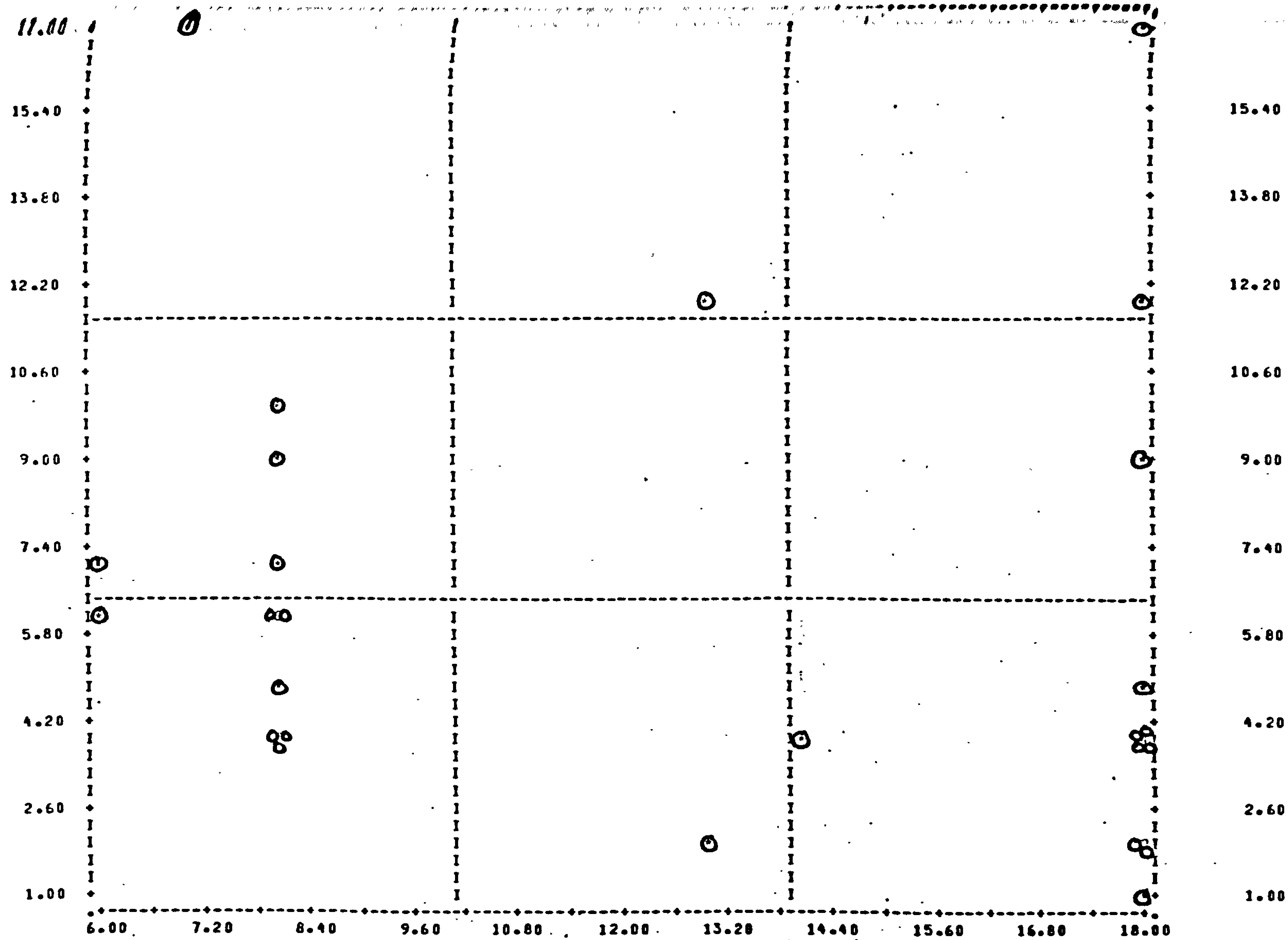
F-14

Mean Age (N) v. Personal Accessibility (R) - Area 12 (Turnhouse)



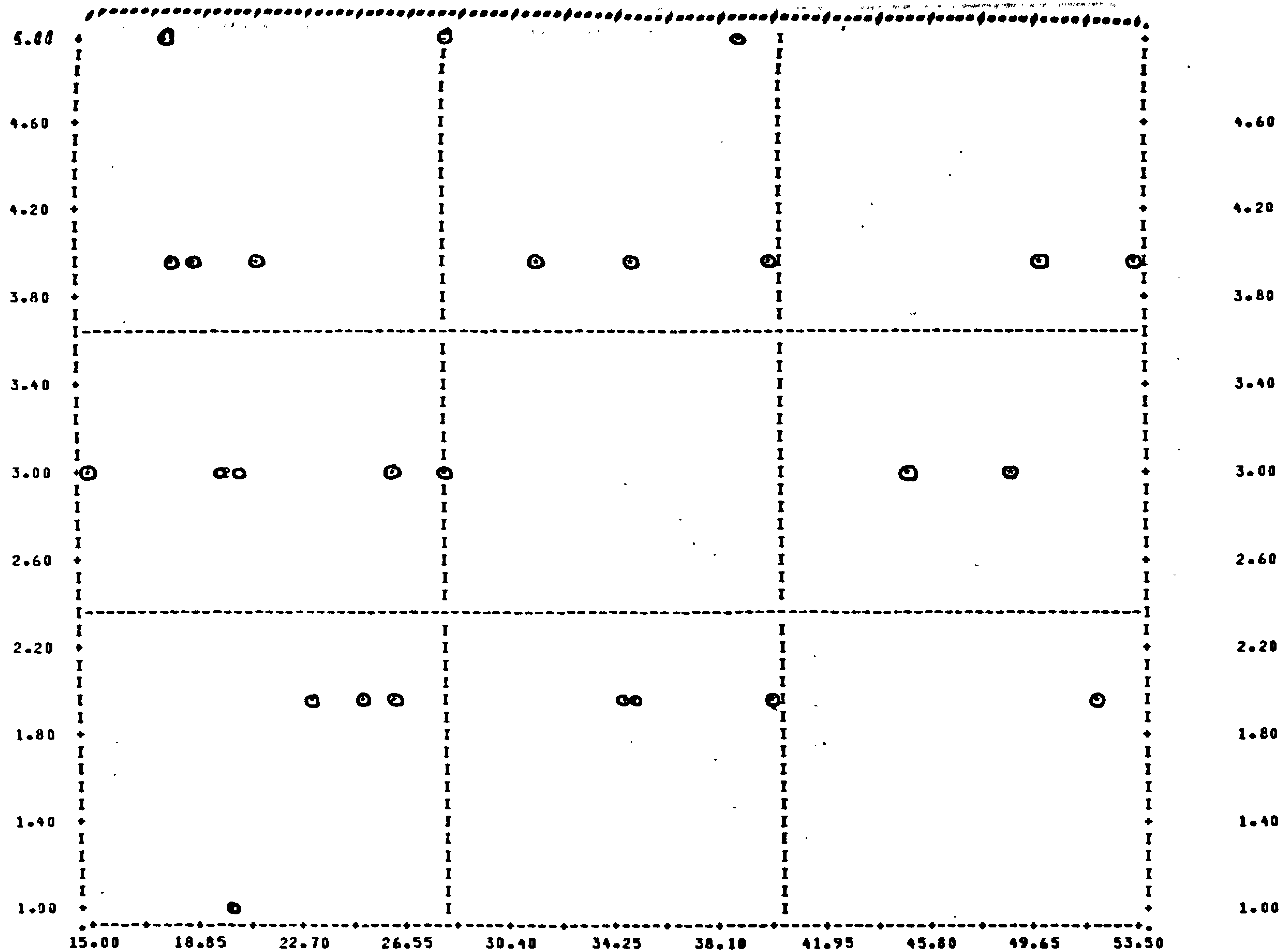
F-15

SD of Ages (O) v. No. of Half Days Employed (Q) - Area 12 (Turnhouse)



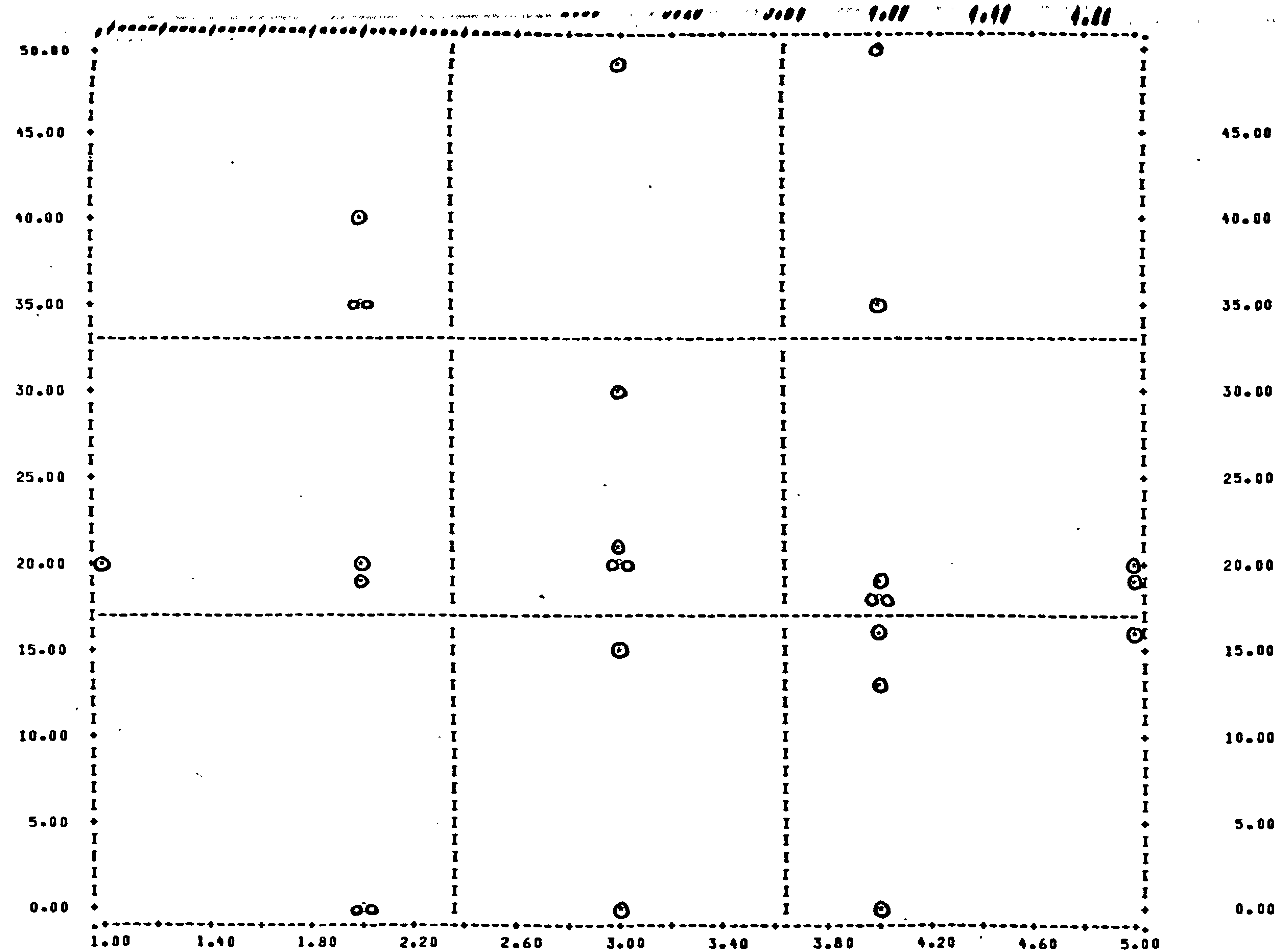
F-16

SEG of Head of Household (P) v. Personal Accessibility (R) - Area 12 (Turnhouse)



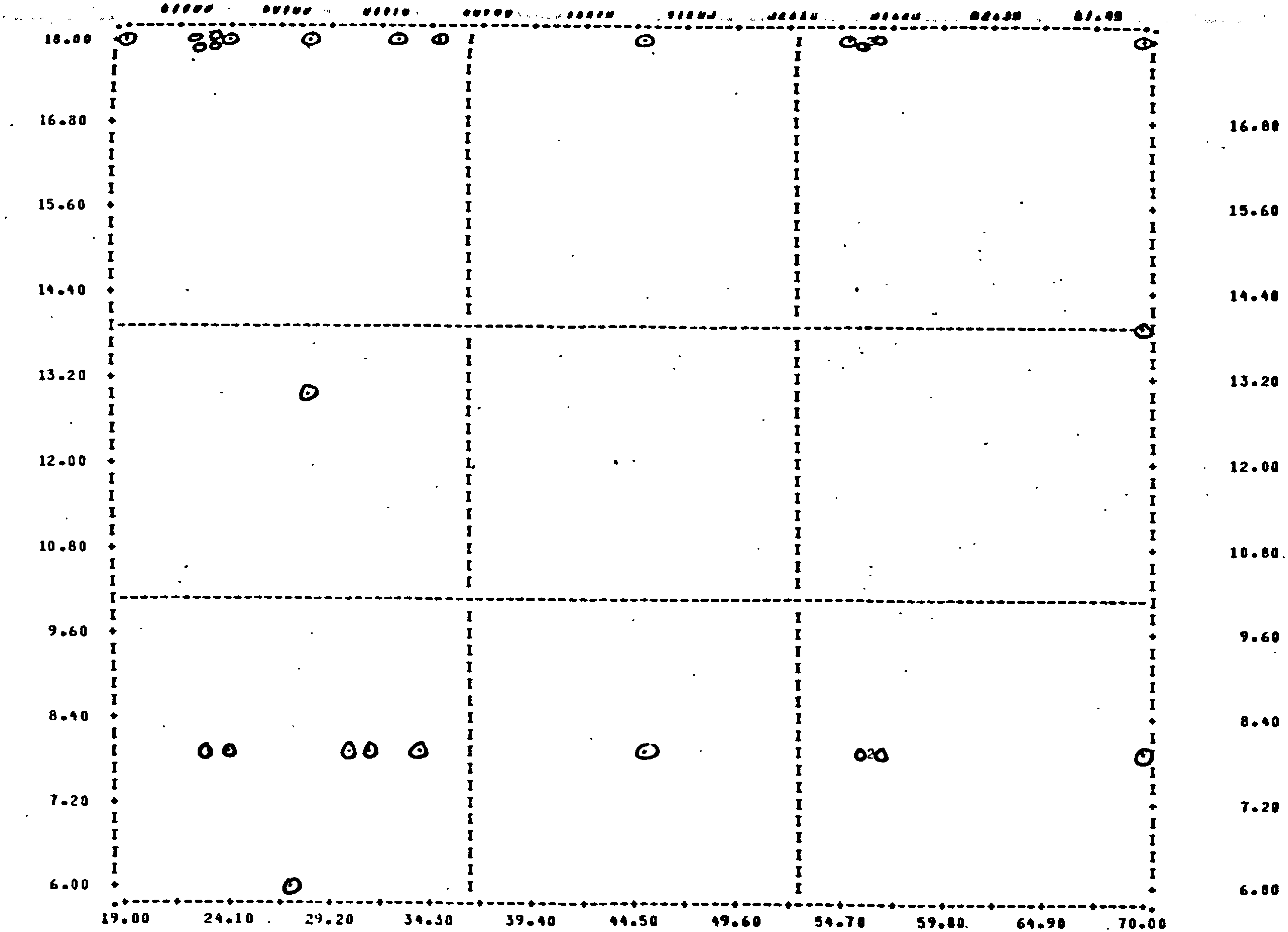
F-17

Total Expenditure/Week (E) v. No. in Household (M) - Area 4 (Swanston)



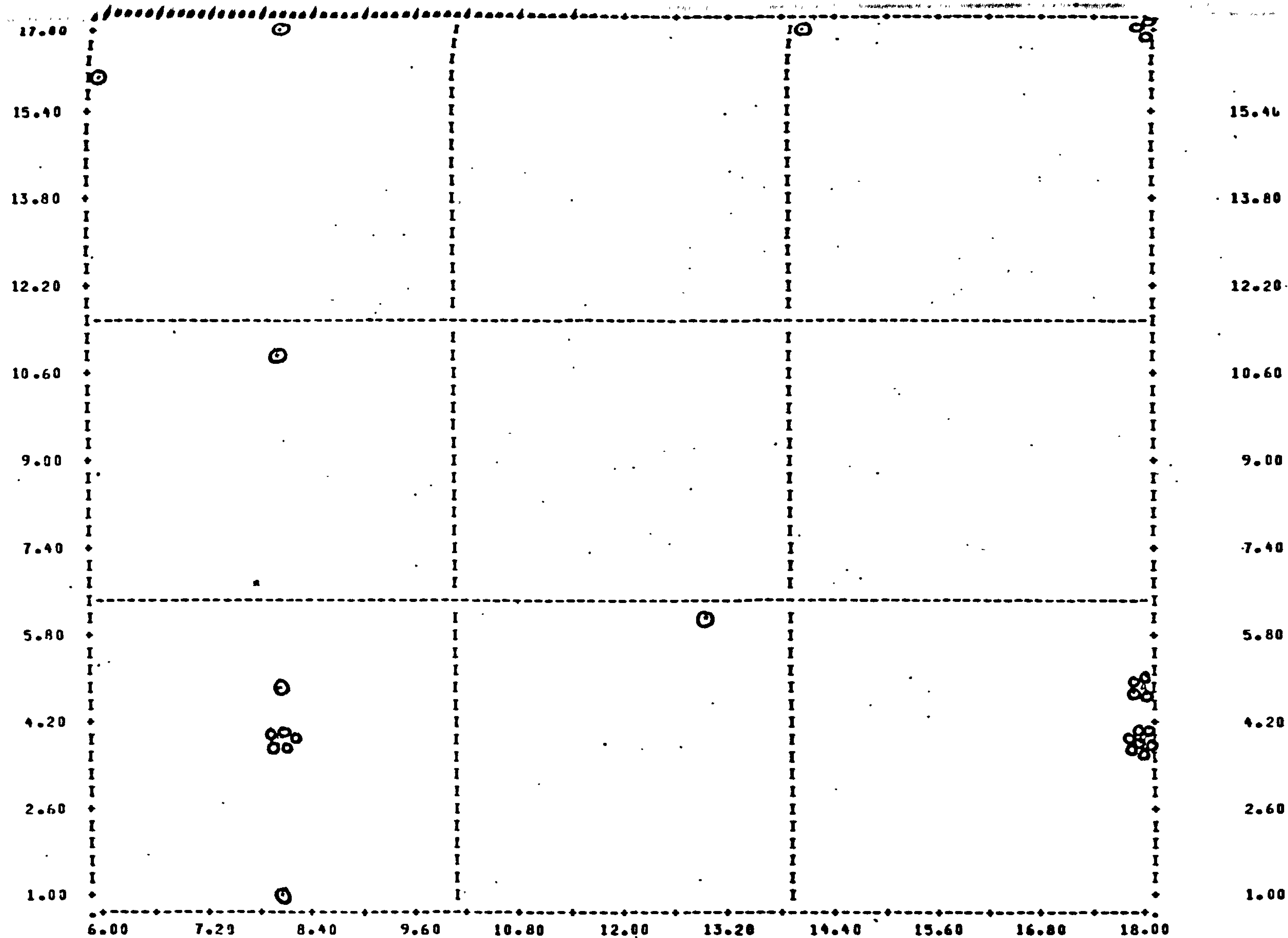
F-18

Expenditure/Week at Store (D) v. No. in Household (M) - Area 4 (Swanston)



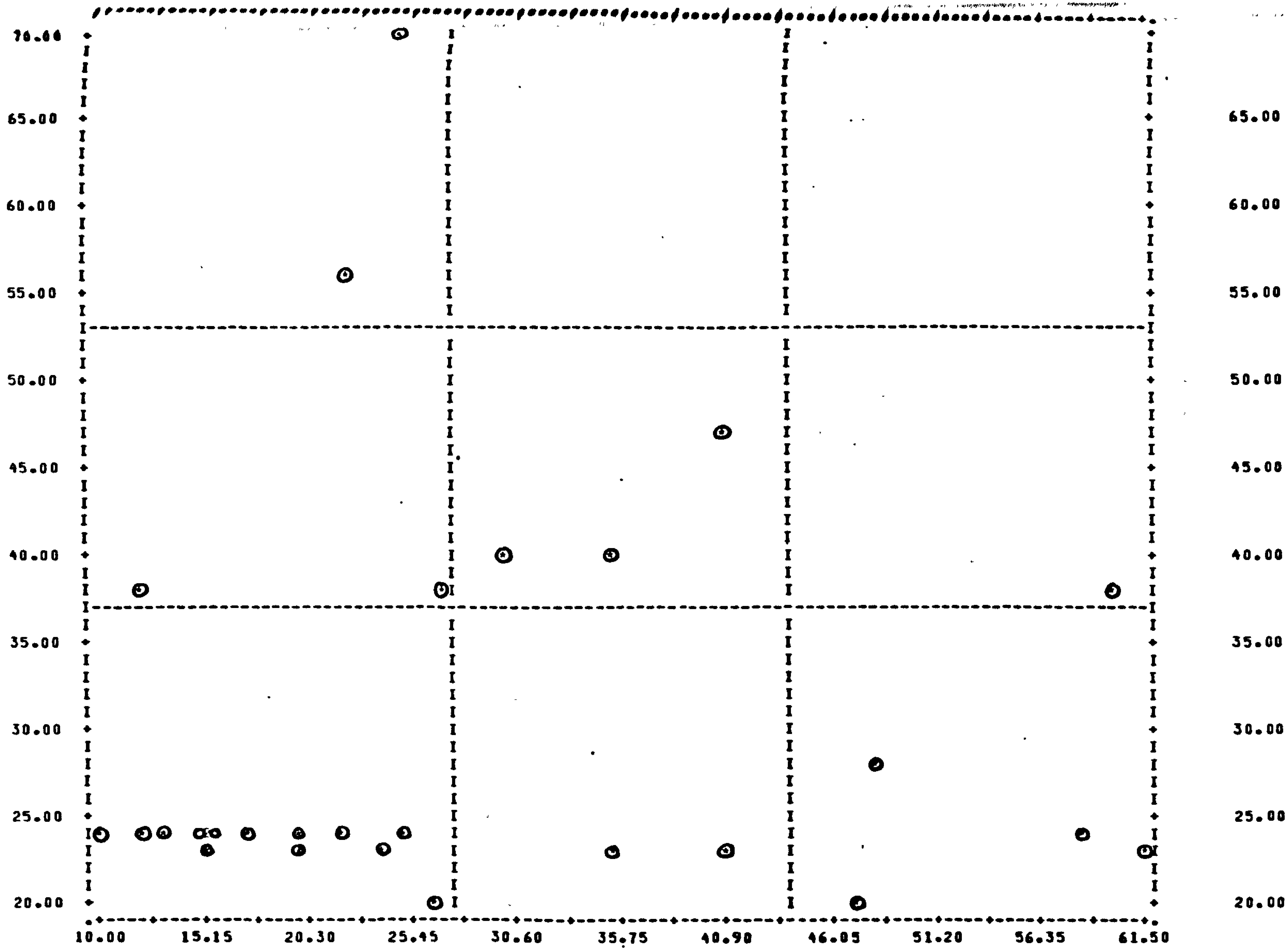
F-19

Mean Age (N) v. Personal Accessibility (R) - Area 4 (Swanston)



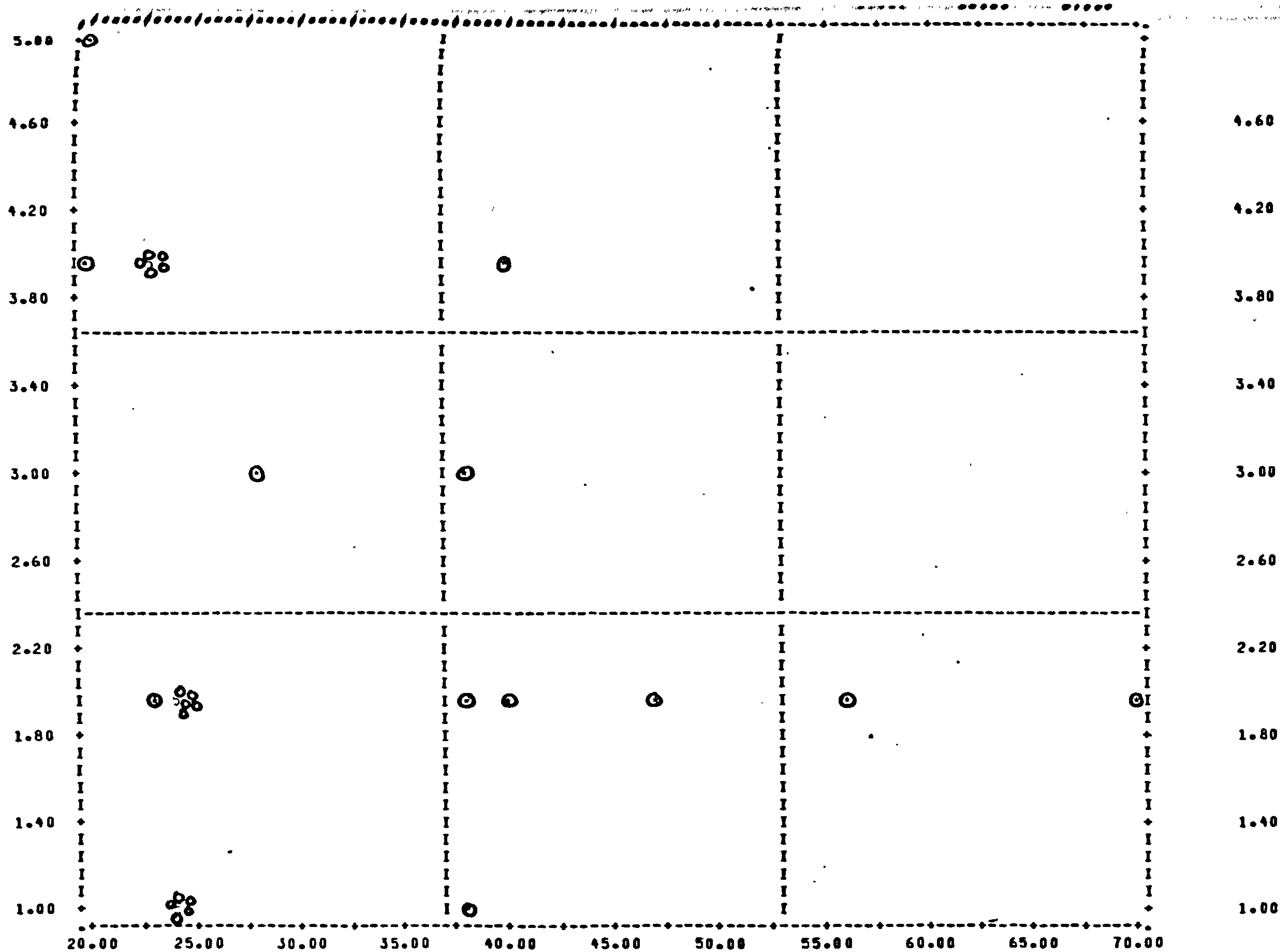
F-20

SEG of Head of Household (P) v. Personal Accessibility (R) - Area 4 (Swanston)



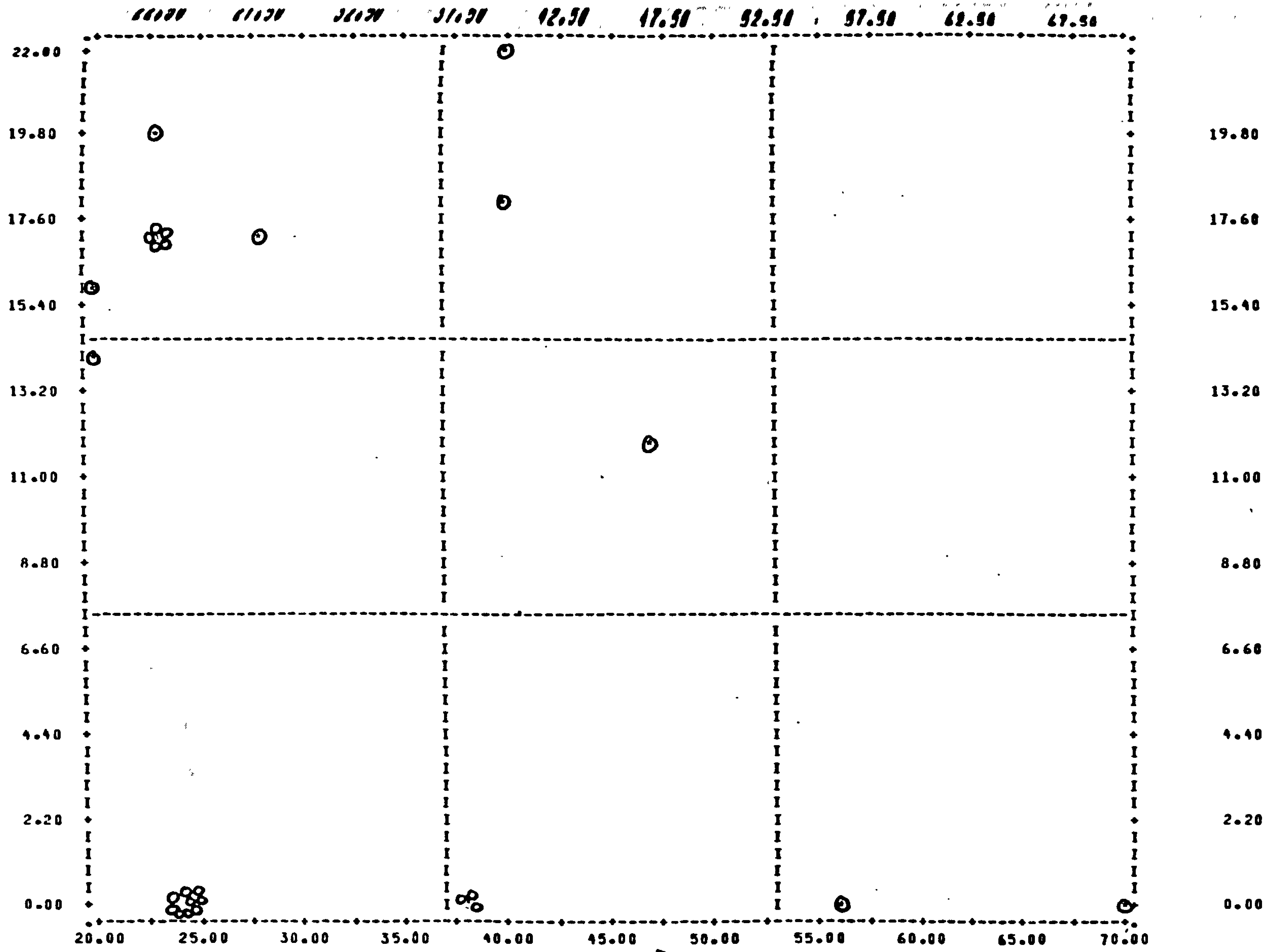
F-21

Total Expenditure/Week (E) v. Mean Age of Household (N) - Area 7 (St Peters Place)



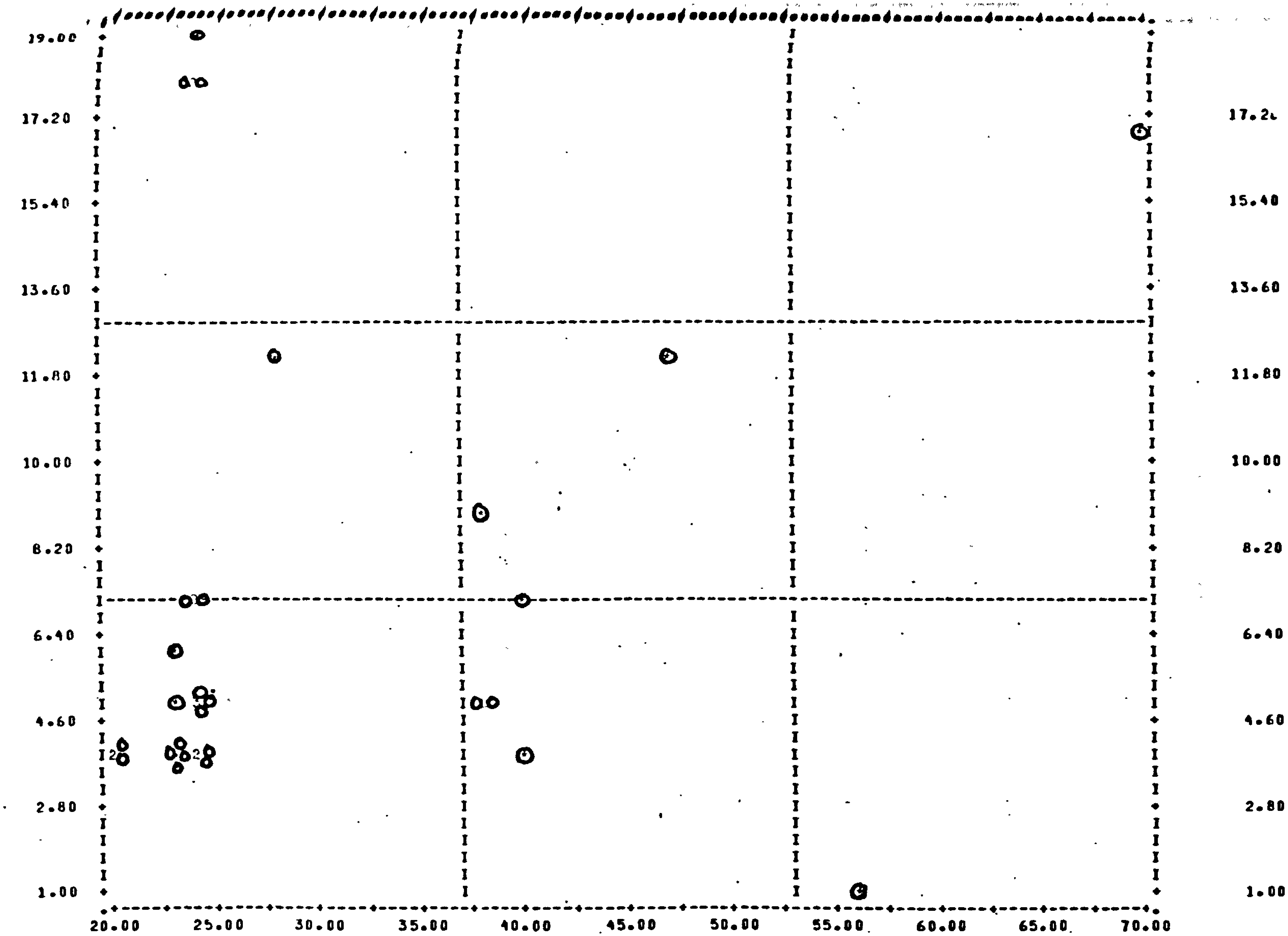
F-22

No. in Household (M) v. Mean Age of Household (N) - Area 7 (St Peters Place)



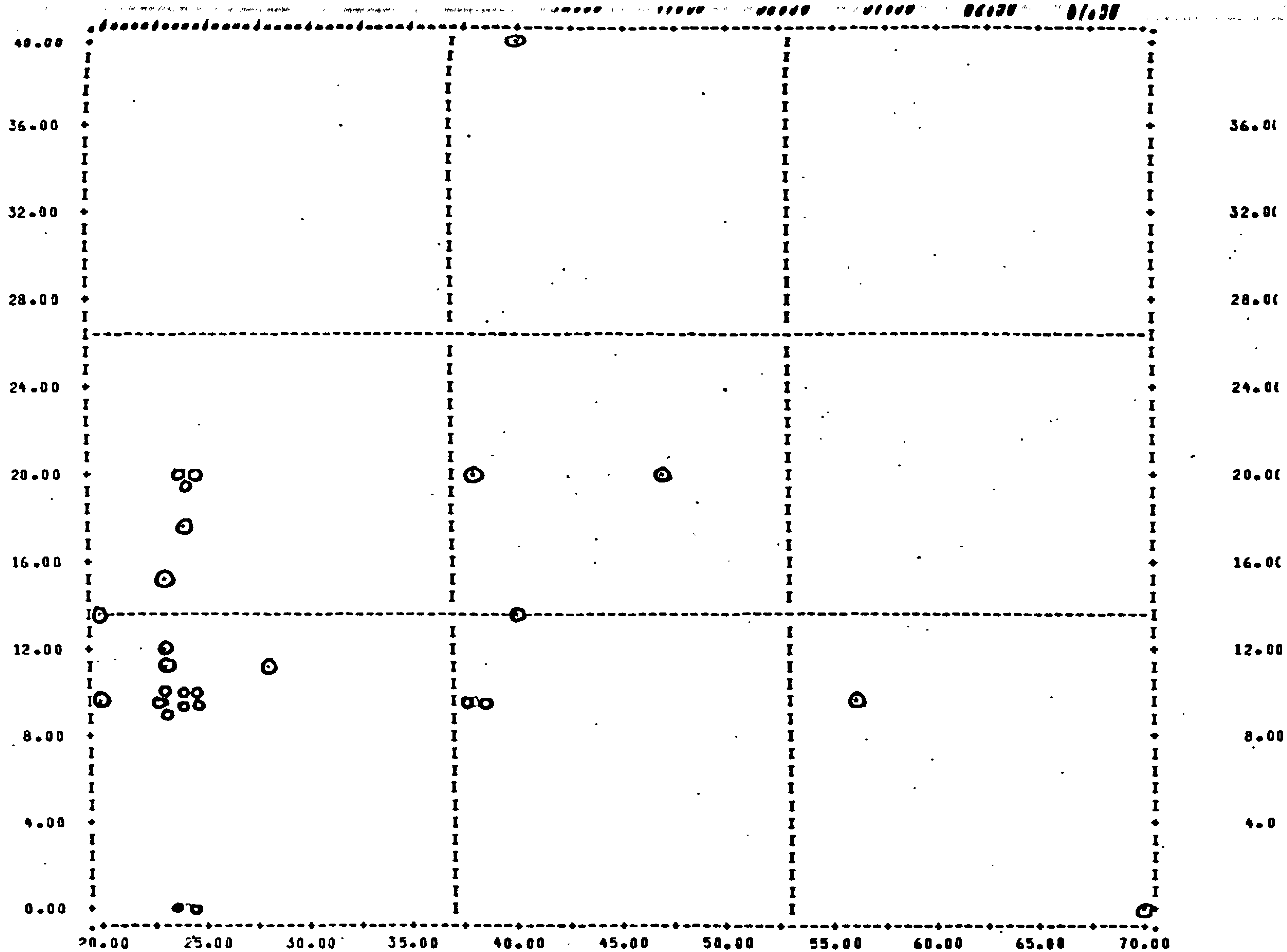
F-23

Mean Age of Structure (N) v. SD of Age Structure (O) - Area 7 (St Peters Place)



F-24

Mean Age of Household (N) v. SEG of Head of Household (P) - Area 7 (St Peters Place)



F-25

Mean of Age Structure (N) v. No. of Half Days Employed (Q) - Area 7 (St Peters Place)

APPENDIX G

FACTOR 1

λ = 1			λ = 2			λ = 3		
F	+	0.85	I	+	0.93	I	+	0.94
B	+	0.84	R	+	0.89	R	+	0.89
D	+	0.63	K	+	0.78	K	+	0.78
S	+	0.57	L	+	0.75	L	+	0.76
L	+	0.43	D	+	0.45	D	+	0.41
K	+	0.42	E	+	0.36	E	+	0.40
O	+	0.35	F	+	0.33	N	+	0.35
M	+	0.24	N	+	0.32	F	+	0.29
R	+	0.21	B	+	0.26	O	+	0.27
E	+	0.18	O	+	0.24	B	+	0.26
Q	+	0.05	M	-	0.03	M	+	0.02
I	+	0.01	G	-	0.06	G	-	0.03
G	-	0.00	Q	-	0.08	* S	-	0.04
C	-	0.02	C	-	0.26	Q	-	0.04
N	-	0.67	* S	-	0.30	C	-	0.17
P	-	0.69	P	-	0.32	P	-	0.31

G-1

Principle Components Analysis for all Variables for λ = 1, 2, and 3

PCA - FACTOR 2

λ = 1			λ = 2			λ = 3		
I	+	0.94	M	+	0.93	M	+	0.88
R	+	0.88	E	+	0.77	Q	+	0.74
K	+	0.78	O	+	0.68	E	+	0.71
L	+	0.75	Q	+	0.66	* S	+	0.63
D	+	0.41	D	+	0.48	O	+	0.62
E	+	0.38	C	+	0.34	D	+	0.48
N	+	0.36	L	+	0.29	K	+	0.31
F	+	0.28	K	+	0.28	L	+	0.30
B	+	0.25	F	+	0.27	F	+	0.25
O	+	0.25	* S	+	0.16	C	+	0.24
S	+	0.09 *	I	+	0.15	I	+	0.13
M	-	0.00	B	+	0.14	B	+	0.09
G	-	0.02	G	+	0.14	G	+	0.04
Q	-	0.06	P	-	0.08	P	-	0.14
C	-	0.18	R	-	0.09	R	-	0.20
P	-	0.31	N	-	0.35	N	-	0.41

G-1 (Contd.)

Principle Components Analysis for all Variables for λ = 1, 2, and 3

PCA - FACTOR 3

λ = 1			λ = 2			λ = 3		
M	+	0.87	B	+	0.86	F	+	0.85
Q	+	0.76	F	+	0.74	B	+	0.84
E	+	0.68	D	+	0.50	D	+	0.62
O	+	0.64	L	+	0.44	* S	+	0.43
* S	+	0.35	K	+	0.38	L	+	0.40
L	+	0.31	O	+	0.31	K	+	0.38
K	+	0.28	M	+	0.18	O	+	0.34
F	+	0.20	R	+	0.17	R	+	0.24
C	+	0.18	E	+	0.09	M	+	0.20
I	+	0.15	C	+	0.07	E	+	0.14
B	+	0.04	Q	+	0.07	G	+	0.01
G	-	0.06	* S	+	0.06	I	-	0.01
P	-	0.13	I	-	0.00	Q	-	0.01
R	-	0.18	G	-	0.04	C	-	0.04
N	-	0.40	N	-	0.65	N	-	0.65
N	-	0.40	P	-	0.75	P	-	0.66

NOTE:

Factor (2) for = 3

G-1 (Contd.)

Principle Components Analysis for all Variables for λ = 1, 2, and 3

PCA - FACTOR 4

λ = 1			λ = 2			λ = 3		
G	+	0.90	G	+	0.87	G	+	0.90
C	+	0.83	C	+	0.70	C	+	0.81
S	+	0.44 *	P	+	0.48	P	+	0.46
P	+	0.44	N	+	0.35	E	+	0.30
N	+	0.32	R	+	0.24	N	+	0.35
E	+	0.36	E	+	0.23	M	+	0.26
M	+	0.31	B	+	0.23	B	+	0.20
B	+	0.21	M	+	0.15	* S	+	0.16
R	+	0.12	F	+	0.11	R	+	0.15
O	+	0.08	O	+	0.02	O	+	0.05
F	+	0.06	I	-	0.14	F	+	0.05
I	-	0.11	* S	-	0.14	I	-	0.13
D	-	0.17	D	-	0.17	D	-	0.20
K	-	0.19	K	-	0.26	K	-	0.24
L	-	0.26	L	-	0.31	L	-	0.29
Q	-	0.36	Q	-	0.56	Q	-	0.42

G-1 (Contd.)

Principle Components Analysis for all Variables for λ = 1, 2, and 3

PCA - FACTOR 5

λ = 1	λ = 2	λ = 3
	* S + 0.90 (Spatial Accessibility)	
	D + 0.50 (Expenditure at Superstore)	
	F + 0.41 (Frequency at Superstore)	
	O + 0.18	
	P + 0.16	
	R + 0.11	
	L + 0.07	
	E + 0.05	
	B - 0.05	
	K - 0.09	
	L - 0.10	
	G - 0.11	
	Q - 0.12	
	I - 0.18	
	N - 0.23 (Mean Age of Household)	
	C - 0.53 (Duration of Total Shopping)	

G-1 (Contd.)

Principle Components Analysis for all Variables for λ = 1, 2, and 3

Eigenvalue	Canonical Correlation Coefficient	Chi-Square	D.F.	Significance Level
$\lambda = 2$:				
1.0	1.0	9999.00	66	0
1.0	1.0	9999.00	50	0
1.0	1.0	9999.00	36	0
0.96	0.98	25.18	24	0.396
0.81	0.90	9.53	14	0.796
0.23	0.48	1.33	6	0.970
$\lambda = 1$:				
1.0	1.0	9999.00	66	0
1.0	1.0	9999.00	50	0
1.0	1.0	84.67	36	0
0.89	0.95	18.50	24	0.778
0.69	0.83	7.26	14	0.924
0.24	0.49	1.37	6	0.968
$\lambda = 3$:				
1.0	1.0	9999.00	66	0
1.0	1.0	9999.00	50	0
1.0	1.0	83.21	36	0
0.85	0.92	14.49	24	0.935
0.51	0.71	5.15	14	0.984
0.28	0.53	1.62	6	0.951

G-2

Canonical Correlation Analysis for $\lambda = 1, 2$ and 3

CONVAR (1) for :

λ = 1			λ = 2			λ = 3		
L	-	3.14	L	-	2.49	L	+	3.35
P	-	1.50	P	-	1.33	* S	+	0.93
N	-	0.53	N	-	0.41	R	+	0.88
M	-	0.17	M	-	0.20	N	+	0.45
* S	+	0.09	* S	-	0.16	Q	+	0.42
Q	+	0.22	I	-	0.12	P	+	0.06
J	+	0.27	J	-	0.09	O	+	0.01
I	+	0.34	Q	+	0.26	M	-	0.36
O	+	0.54	O	+	0.26	I	-	0.57
K	+	0.67	K	+	0.92	K	-	1.33
R	+	1.36	R	+	1.30	J	-	1.82
B	+	0.99	B	+	0.95	E	+	0.98
D	+	0.39	D	+	0.31	B	+	0.75
G	+	0.25	G	-	0.03	F	+	0.03
F	-	0.14	F	-	0.08	G	-	0.31
E	-	0.34	C	-	0.15	D	-	0.50
C	-	0.36	E	-	0.28	C	-	0.58

G-3

Canonical Variate Structures for $\lambda = 1, 2$ and 3

CONVAR (2) for :

λ = 1	λ = 2	λ = 3
L - 4.94	L + 5.38	L + 4.04
N - 1.01	P + 1.22	P + 1.08
P - 0.97	N + 1.06	N + 0.93
O - 0.47	O + 0.36	K + 0.53
Q - 0.15	Q + 0.13	O + 0.50
* S - 0.05	K - 0.03	Q - 0.05
M + 0.35	M - 0.1	M - 0.21
R + 0.91	R - 1.05	* S - 0.34
I + 1.75	I - 1.88	J - 1.32
J + 1.93	J - 2.01	I - 1.67
G + 1.40	G - 1.45	G - 1.40
B + 0.75	B - 0.81	B - 1.22
E - 0.05	E - 0.19	E - 0.40
F - 0.36	F + 0.37	F + 0.38
D - 0.65	D + 0.41	D + 0.96
C - 1.29	C + 1.28	C + 1.71

G-3 (Contd.)

Canonical Variate Structures for λ = 1, 2 and 3

CONVAR (3) for :

λ = 1			λ = 2			λ = 3		
L	-	4.15	L	+	1.30	L	+	5.74
O	+	0.93	R	+	0.90	P	+	1.73
* S	+	0.86	Q	+	0.50	* S	+	0.85
Q	+	0.63	P	+	0.50	N	+	0.74
R	+	0.43	K	+	0.16	Q	+	0.14
N	+	0.37	M	-	0.02	M	-	0.02
I	-	0.13	N	-	0.11	I	-	0.26
M	-	0.32	O	-	0.57	R	-	0.49
O	-	0.84	* S	-	0.89	O	-	1.02
J	-	1.54	I	-	0.92	J	-	1.47
K	-	1.94	J	-	1.12	K	-	2.38
E	+	2.02	E	+	1.64	E	+	1.64
B	+	1.13	B	+	1.39	F	+	0.05
G	+	0.05	F	-	0.10	G	-	0.02
F	-	0.13	F	-	0.14	B	-	0.08
C	-	1.68	C	-	1.29	C	-	1.58
D	-	2.22	D	-	2.56	D	-	1.58

G-3 (Contd.)

Canonical Variate Structures for λ = 1, 2 and 3

APPENDIX H

BEST COPY AVAILABLE

Variable print quality

FILE [illegible] (CREATION DATE = 06/07/83)

* M U L T I P L E   R E G R E S S I O N * * * * * * * * * * * * * * * * * VARIABLE LIST 1
REGRESSION LIST 1

DEPENDENT VARIABLE.. F

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
I	0.40424	0.16341	0.16341	0.40424	0.5017987	0.43029
Q	0.53439	0.28557	0.12216	-0.33572	-0.2706648E-01	-0.37001
O	0.59029	0.34844	0.06287	-0.13914	-0.1545591E-03	-0.00306
K	0.60575	0.36653	0.01848	0.21087	0.1679079	0.44564
R	0.63138	0.39864	0.03172	-0.10376	0.6600666E-01	0.57424
J	0.70928	0.50308	0.10444	-0.16532	-1.606931	-0.59666
L	0.71204	0.50700	0.00392	0.16507	0.6874291E-01	0.09124
N	0.71559	0.51207	0.00507	0.14016	0.9634355E-02	0.29557
P	0.72556	0.52643	0.01436	-0.07981	-0.4568104E-01	-0.46294
M	0.72674	0.52814	0.00171	0.02722	-0.6596925E-01	-0.11377
(CONSTANT)					1.138853	

H-1

Area 1 – Multiple Regression Analysis F with I to R; F with B, D; B with I to R; and D with I to R

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TR1                                                     14:46:54  06/07/83  PAGE  13
FILE  F1    (CREATION DATE = 06/07/83)
* * * * * * * * * * * * * * * * * * * * * * * *  M U L T I P L E   R E G R E S S I O N  * * * * * * * * * * * * * *   VARIABLE LIST  1
                                                                                                          REGRESSION LIST  2
DEPENDENT VARIABLE..    F
```

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
[illegible]	0.91575	0.83860	0.838[illegible]	0.91575	0.5511403	0.56034
[illegible]	0.95777	0.91732	0.07873	0.79262	0.1625837E-01	0.45242
(CONSTANT)					0.2585335E-01	

H-1 (Contd.)

Area 1 – Multiple Regression Analysis F with I to R; F with B, D; B with I to R; and D with I to R

FILE F1 (CREATION DATE = 06/07/83)

* M U L T I P L E   R E G R E S S I O N * * * * * * * * * * * * * * * * * * VARIABLE LIST 1
DEPENDENT VARIABLE.. [illegible] REGRESSION LIST 3

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R		BETA
I	0.30378	0.09228	0.09228	0.[illegible]	0.[illegible]047[illegible]	0.256[illegible]5
G	0.42208	0.17815	0.08[illegible]	-0.[illegible]8[illegible]64	-0.1[illegible]7[illegible] E-01	-0.115[illegible]5
K	0.46[illegible]5	0.21460	0.03645	0.26[illegible]17	0.3233[illegible]7	0.[illegible]
J	0.51661	0.26698	0.05228	-0.102[illegible]	-0.5715[illegible]	-0.[illegible]59[illegible]
R	0.60002	0.36002	0.09314	-0.11553	0.7152413E-01	0.3[illegible]84-
M	0.60553	0.36666	0.00664	0.17754	0.3296[illegible]	0.3[illegible]6[illegible]8
N	0.64563	0.41683	0.05017	0.04553	0.31667-.E-01	0.57936
P	0.65830	0.43336	0.01653	-0.17053	-0.71623[illegible]E-01	-0.42586
(CONSTANT)					0.147531[illegible]	

H-1 (Contd.)

Area 1 – Multiple Regression Analysis F with I to R; F with B, D; B with I to R; and D with I to R

FILE F1 (CREATION DATE = [illegible])

. . . . M U L T I P L E R E G R E S S I O N . . . . VARIABLE LIST 1
REGRESSION LIST 4

DEPENDENT VARIABLE.. [illegible]

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
I	0.42725	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
G	0.56077	0.31447	[illegible]	[illegible]	[illegible]	[illegible]
O	0.62733	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	0.67593	0.45563	[illegible]	[illegible]	[illegible]	0.61074
L	0.69069	0.47705	0.02142	[illegible]	5.23317[illegible]	[illegible]
P	0.70610	0.49857	[illegible]	-0.12337	[illegible]	[illegible]
J	0.72553	0.52640	[illegible]	-0.04491	[illegible]	[illegible]
M	0.73169	0.53537	[illegible]	[illegible]	[illegible]	0.24129
N	0.73667	0.54218	0.00721	[illegible]	[illegible]	[illegible]
(CONSTANT)					-9.975169	

H-1 (Contd.)

Area 1 – Multiple Regression Analysis F with I to R; F with B, D; B with I to R; and D with I to R

FILE F1 (CREATION DATE = 05/07/83)

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * * VARIABLE LIST 1
REGRESSION LIST 1

DEPENDENT VARIABLE.. F

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R		BETA
R	0.23239	0.05[illegible]6	0.053[illegible]	-0.23230	[illegible]	[illegible]
I	0.33786	0.11415	0.0[illegible]	-0.2037[illegible]	[illegible]	[illegible]
[illegible]	0.38[illegible]	0.146[illegible]4	0.03275	-0.10[illegible]	[illegible]	[illegible]
J	0.40525	0.16423	0.017[illegible]	[illegible]	[illegible]	0.380[illegible]
L	0.41610	0.17514	0.00851	-0.165[illegible]	-0.[illegible]2670[illegible]E-01	[illegible]
[illegible]	0.43175	0.18644	0.0133[illegible]	[illegible]	-0.1[illegible]E-01	[illegible]
J	0.43727	0.19170	0.00477	0.046[illegible]2	0.1387171	0.0977[illegible]
K	0.43913	0.19283	0.00163	-0.11078	-0.2530547E-01	-0.076[illegible]
(CONSTANT)					1.04486[illegible]	

H-2

Area 2 – Multiple Regression Analysis F with I to R; F with B, D; B with I to R; and D with I to R

```
FILE   F1        (CREATION DATE = 06/07/83)                              14:48:47.  06/07/83   PAGE   11

* * * * * * * * * * * * * * * * * * * * * * * *  M U L T I P L E   R E G R E S S I O N  * * * * * * * * * * * *   VARIABLE LIST  1
                                                                                                                    REGRESSION LIST  2
DEPENDENT VARIABLE..   F

                                          SUMMARY TABLE
```

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
[illegible]	0.82492	0.68049	0.68049	0.82492	0.[illegible]	[illegible]
[illegible]	0.82769	0.68506	0.00457	0.68277	0.[illegible]	[illegible]
(CONSTANT)					[illegible]	

H-2 (Contd.)

Area 2 - Multiple Regression Analysis F with I to R; F with B, D; B with I to R; and D with I to R

TP1 14:48:47 06/07/83 PAGE 18

FILE F1 (CREATION DATE = 06/07/83)

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * * VARIABLE LIST 1
REGRESSION LIST [illegible]

DEPENDENT VARIABLE.. [illegible]

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	[illegible]	BETA
R	0.19914	0.039[illegible]	0.0[illegible]	-0.19514	-0.[illegible]E-01	-0.1[illegible]
P	0.26732	0.07146	0.031[illegible]	0.2496[illegible]	[illegible]E-01	[illegible]
J	0.30636	0.09386	0.02240	0.12849	[illegible]	[illegible]
O	0.34952	0.12216	0.02831	-0.119[illegible]	-0.[illegible]E-01	-0.84[illegible]
[illegible]	0.47457	0.22531	0.10315	0.01847	0.45099[illegible]	[illegible]
V	0.49628	0.24[illegible]	0.0205[illegible]	-0.13595	-0.1[illegible]E-01	-0.4[illegible]7
L	0.54067	0.29232	0.046[illegible]	-0.12271	-0.372071[illegible]	-0.3[illegible]
Q	0.54451	0.29649	0.00417	-0.00872	-0.1132[illegible]E-01	-0.12[illegible]
(CONSTANT)					1.0061[illegible]	

H-2 (Contd.)

Area 2 - Multiple Regression Analysis F with I to R; F with B, D; B with I to R; and D with I to R

FILE F1 (CREATION DATE = 06/07/83)

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * VARIABLE LIST 1
REGRESSION LIST 4

DEPENDENT VARIABLE.. [illegible]

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
[illegible]	0.58435	0.34147	0.34147	[illegible]	[illegible]	[illegible]
[illegible]	0.67991	0.46227	0.12081	-0.46315	[illegible]	[illegible]
[illegible]	0.70351	0.49452	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	0.74827	0.55990	0.06458	[illegible]	[illegible]	[illegible]
[illegible]	0.75999	0.57758	0.01768	-0.05817	[illegible]	[illegible]
[illegible]	0.78076	0.60959	0.03201	0.42795	[illegible]	[illegible]
[illegible]	0.78719	0.61966	0.01007	0.46555	[illegible]	[illegible]
[illegible]	0.78957	0.62342	0.00376	-0.35911	[illegible]	[illegible]
(CONSTANT)					[illegible]	

H-2 (Contd.)

Area 2 - Multiple Regression Analysis F with I to R; F with B, D; B with I to R; and D with I to R

[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

H-3

Area 3 - Multiple Regression Analysis F with I to R; F with B, D; B with I to R; and D with I to R

FILE F1 (CREATION DATE = 06/07/63)

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * * VARIABLE LIST 1
REGRESSION LIST 1

DEPENDENT VARIABLE..

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
[illegible]	0.82085	0.67387	0.67387	0.820[illegible]	[illegible]74077[illegible]	[illegible]
[illegible]	0.83662	0.70693	0.17[illegible]	[illegible]11[illegible]	.15177 [illegible]	[illegible]
(CONSTANT)					0.1279[illegible]	

H-3 (Contd.)

Area 3 – Multiple Regression Analysis F with I to R; F with B, D; B with I to R; and D with I to R

FILE F1 (CREATION DATE = 06/[illegible]/83)

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * * VARIABLE LIST [illegible]
REGRESSION LIST [illegible]

DEPENDENT VARIABLE..

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
I	0.47555	0.22643	0.22643	0.47555	[illegible]	[illegible]
[illegible]	0.54740	0.29971	0.07328	0.47324	[illegible]	[illegible]
[illegible]	0.68856	0.47416	0.17445	0.11764	[illegible]	[illegible]
[illegible]	0.71638	0.51320	0.03905	-0.28774	[illegible]	[illegible]
[illegible]	0.74176	0.55023	0.03703	-0.09761	[illegible]	[illegible]
[illegible]	0.75059	0.56338	0.01315	0.01674	-0.11[illegible]	[illegible]
[illegible]	0.75167	0.56504	0.00166	-0.14246	[illegible]	[illegible]
[illegible]	0.75291	0.56542	0.00048	-0.27902	-0.4[illegible]	[illegible]
(CONSTANT)					-0.7[illegible]	

H-3 (Contd.)

Area 3 - Multiple Regression Analysis F with I to R; F with B, D; B with I to R; and D with I to R

FILE · F1 (CREATION DATE = 06/07/85)

· M U L T I P L E R E G R E S S I O N · · · · · · · · · · · · · · VARIABLE LIST 1
REGRESSION LIST 4

DEPENDENT VARIABLE..

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
[illegible]	0.42774	0.18296	0.18296	0.42774	[illegible]	0.171[illegible]
[illegible]	0.47224	0.22301	0.040[illegible]	-0.15227	-1.[illegible]	[illegible]
[illegible]	0.61302	0.37579	0.15278	0.11726	6.19[illegible]	[illegible]
[illegible]	0.63113	0.39832	0.02253	-0.09661	1.14[illegible]	[illegible]
I	0.68227	0.46549	0.06717	[illegible]	-1.71[illegible]	-0.44[illegible]
[illegible]	0.71013	0.50428	0.03879	0.21869	[illegible].205729	0.321[illegible]
[illegible]	0.74407	0.55365	0.04937	0.26548	[illegible]	0.411[illegible]
[illegible]	0.75023	0.56285	0.00920	-0.25649	-0.1951[illegible]	-0.17777
(CONSTANT)					-11.6747[illegible]	

H-3 (Contd.)

Area 3 – Multiple Regression Analysis F with I to R; F with B, D; B with I to R; and D with I to R

ILE F1 (CREATION DATE = 04/27/83)

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * * VARIABLE LIST 1
DEPENDENT VARIABLE.. [illegible] REGRESSION LIST 1

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
[illegible]	0.22498	0.05017	0.05017	-0.22398	[illegible]	[illegible]
[illegible]	0.31645	0.10141	0.05124	-0.16054	[illegible]	[illegible]
[illegible]	0.42596	0.18146	[illegible]	-0.13662	[illegible]	[illegible]
L	0.51244	0.24305	0.06159	-0.22147	[illegible]	[illegible]
[illegible]	0.53547	0.28673	0.02368	-0.05667	[illegible]	[illegible]
[illegible]	0.55821	0.31160	0.02487	-0.01345	[illegible]	[illegible]
[illegible]	0.57195	0.32713	0.01553	0.09164	0.14146[illegible]-01	0.2[illegible]
[illegible]	0.57619	0.33198	0.00486	0.05415	[illegible]	0.24[illegible]
[illegible]	0.57795	0.33403	0.00204	0.01941	-0.611617[illegible]	-0.0[illegible]
I	0.57905	0.33521	0.00129	0.06238	[illegible]-01	-0.07[illegible]
(CONSTANT)					3.51329[illegible]	[illegible]

Additional legible values in the B and BETA columns: B [illegible] 0.71817[illegible]-01; BETA 1.06477 (row alignment uncertain).

H-4

Area 4 - Multiple Regression Analysis F with I to R; F with B, D; B with I to R; and D with I to R

FILE F1 (CREATION DATE = [illegible])

* M U L T I P L E R E G R E S S I O N * VARIABLE LIST 1 REGRESSION LIST 2

DEPENDENT VARIABLE.. F

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
D	0.80875	0.65409	[illegible]	[illegible]	0.1957475[illegible]	[illegible]
[illegible]	0.84592	[illegible]	[illegible]	0.77[illegible]	[illegible]	[illegible]
(CONSTANT)					[illegible]	

H-4 (Contd.)

Area 4 – Multiple Regression Analysis F with I to R; F with B, D; B with I to R; and D with I to R

FILE F1 (CREATION DATE = [illegible])

* MULTIPLE REGRESSION * * * * * * * * * * * * * * [illegible]

[illegible] VARIABLE.. [illegible]

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	[illegible]
[illegible]	0.15653	0.02450	0.0245[illegible]	-0.15[illegible]	-0.[illegible]	[illegible]
I	0.33543	0.112[illegible]	0.0[illegible]	-0.0[illegible]	-0.1[illegible]	[illegible]
[illegible]	0.35795	0.12813	0.01[illegible]	-0.[illegible]67[illegible]7	-0.[illegible]	[illegible]
3	0.36[illegible]57	0.13219	0.0[illegible]	-0.[illegible]7	-0.[illegible]	-0.1[illegible]
R	0.36805	0.13546	0.0[illegible]7	-0.[illegible]	0.11142[illegible]	0.1[illegible]
4	0.37112	0.15773	0.0[illegible]	-0.[illegible]701[illegible]	-0.21566[illegible]	-0.1[illegible]
J	0.37576	0.14119	0.00346	-0.12[illegible]	-0.51772[illegible]	-0.[illegible]
(CONSTANT)	0.37[illegible]59	0.143[illegible]4	0.00274	-0.11[illegible]	-0.1105[illegible]	-0.[illegible]
					3.767[illegible]	

H-4 (Contd.)

Area 4 - Multiple Regression Analysis F with I to R; F with B, D; B with I to R; and D with I to R

FILE F1 ([illegible] DATE = 05/07/83)

* MULTIPLE REGRESSION * * * * * * * * * * * * * * VARIABLE LIST 1
DEPENDENT VARIABLE.. [illegible] REGRESSION LIST 4

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
R	0.26573	0.07061	0.07061	-0.26573	[illegible]	[illegible]
J	0.31996	0.05670	0.026[illegible]	-0.09149	-3.5[illegible]	[illegible]
I	0.33537	0.11247	0.01379	0.[illegible]117	1.[illegible]	[illegible]
[illegible]	0.35[illegible]	0.12955	0.017[illegible]	-0.042[illegible]	-4.[illegible]	[illegible]
[illegible]	0.39427	0.15545	0.0[illegible]	-0.09464	[illegible]	[illegible]
K	0.41[illegible]7	0.16554	0.[illegible]	0.184[illegible]	2.[illegible]	[illegible]
[illegible]	0.41772	0.17459	0.[illegible]	0.01552	[illegible]32	0.174[illegible]
[illegible]	0.41946	0.17595	0.00145	0.02501	-1.118[illegible]	[illegible]7
[illegible]	0.42105	0.17726	0.001[illegible]	-0.05454	[illegible]	[illegible]4
(CONSTANT)					55.47033	

H-4 (Contd.)

Area 4 – Multiple Regression Analysis F with I to R; F with B, D; B with I to R; and D with I to R

MULTIPLE REGRESSION

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	0.18055	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
(CONSTANT)	0.44275	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

H-5

Area 5 - Multiple Regression·Analysis F with I to R; F with B, D; B with I to R; and D with I to R

FILE [illegible]

. . . . M U L T I P L E   R E G R E S S I O N . . . . VARIABLE LIST 1
REGRESSION LIST 1

DEPENDENT VARIABLE.. [illegible]

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
F	[illegible]	0.55474	0.55474	0.74[illegible]	[illegible]	[illegible]
	0.78[illegible]	0.61948	0.06474	[illegible]	[illegible]	[illegible]
(CONSTANT)					[illegible]	

H-5 (Contd.)

Area 5 - Multiple Regression Analysis F with I to R; F with B, D; B with I to R; and D with I to R

FILE F1 (CREATION DATE = 06/07/83)

* M U L T I P L E   R E G R E S S I O N * * * * * * * * * * * * * VARIABLE LIST 1
DEPENDENT VARIABLE.. REGRESSION LIST 1

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
[illegible]	0.13714	0.01881	0.01881	-0.13714	0.1977[illegible]	0.[illegible]
[illegible]	0.19547	0.03837	0.01956	0.03645	0.4252717	[illegible]
[illegible]	0.24962	0.06231	0.02394	-0.10275	-0.[illegible]E-[illegible]	-[illegible]
[illegible]	0.29722	0.08834	0.02603	-0.06574	-0.[illegible]E-[illegible]	-[illegible]213
[illegible]	0.32790	0.10752	0.01918	0.07527	0.[illegible]E-[illegible]	0.[illegible]
[illegible]	0.36341	0.13207	0.02455	-0.12[illegible]	-1.417[illegible]	-[illegible]
[illegible]	0.38526	0.14842	0.01635	.01177	0.3711954E-01	0.[illegible]
[illegible]	0.40071	0.16057	0.01214	0.12062	0.2575723E-01	0.[illegible]
[illegible]	0.40559	0.16450	0.00394	0.10981	0.1246792	[illegible]
(CONSTANT)					-0.4123217	

H-5 (Contd.)

Area 5 - Multiple Regression Analysis F with I to R; F with B, D; B with I to R; and D with I to R

[illegible]ILE F1 (CREATION DATE = 05/07/83)

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * * * VARIABLE LIST 1
[illegible] LIST 4

DEPENDENT VARIABLE.. D

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
	• 0.43272	0.18725	0.18725	0.43272	1.[illegible]	[illegible]
	• 0.51562	0.26586	0.07862	-0.1242[illegible]	[illegible]	[illegible]
	• 0.[illegible]254	0.33[illegible]	0.0734[illegible]	[illegible]	[illegible]	[illegible]
	0.[illegible]753	0.35704	0.0176[illegible]	-0.11172	0.1[illegible]	[illegible]
	0.[illegible]041	0.3[illegible]50	0.00[illegible]	0.081[illegible]	-[illegible]	-[illegible]
	0.[illegible]191	0.3622[illegible]	0.[illegible]	0.35776	3.[illegible]7	[illegible]
	0.61104	0.37337	0.01[illegible]7	-0.[illegible]4133	0.[illegible]	[illegible]
	0.61218	0.37476	0.001[illegible]	0.33286	-8.[illegible]	-[illegible]
	0.61378	0.37672	0.0019[illegible]	[illegible]0721	1.31[illegible]	[illegible]
	0.61461	0.37775	0.00103	0.[illegible]1120	-0.[illegible]2724[illegible]E-01	-0.[illegible]7237
(CONSTANT)					-23.18812	

H-5 (Contd.)

Area 5 – Multiple Regression Analysis F with I to R; F with B, D; B with I to R; and D with I to R

FILE [illegible] (CREATION DATE = [illegible])

* M U L T I P L E   R E G R E S S I O N * * * * * * * * * * * * * * [illegible] LIST 1

DEPENDENT VARIABLE.. F [illegible] LIST 1

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
[illegible]	0.45728	0.20910	0.20910	0.4572[illegible]	[illegible]	.7[illegible]24[illegible]
J	0.[illegible]556[illegible]	0.[illegible]	0.0777[illegible]	[illegible]	1.[illegible]	.[illegible]411
I	[illegible]	[illegible]7446	0.[illegible]7[illegible]	-0.[illegible]	-0.77[illegible]4[illegible]4	-[illegible]
[illegible]	0.[illegible]079	0.477[illegible]6	0.1[illegible]2[illegible]	[illegible]	-[illegible]747[illegible]	-.[illegible]44
[illegible]	[illegible].717[illegible]	[illegible].[illegible]15[illegible]	0.[illegible]	-[illegible]	-[illegible].777[illegible]	-.31[illegible]41
[illegible]	0.73221	0.53613	0.02078	-0.100[illegible]7	[illegible]45-[illegible]	.21[illegible]
[illegible]	0.74159	0.549[illegible]5	0.01[illegible]	0.106[illegible]4	0.1[illegible]7[illegible]1[illegible]7	.21[illegible]
[illegible]	0.74666	0.557[illegible]1	0.00755	0.34[illegible]77	[illegible].1514747[illegible]- 1	.[illegible]
[illegible]	0.75464	0.56948	0.01157	-0.[illegible]75	0.6[illegible]1[illegible]-[illegible]	.1[illegible]7[illegible]
(CONSTANT)					-1.[illegible]	

H-6

Area 6 – Multiple Regression Analysis F with I to R; F with B, D; B with I to R; and D with I to R

FILE F1 (CREATION DATE = [illegible])

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * * VARIABLE LIST 1
REGRESSION LIST 2

DEPENDENT VARIABLE.. F

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
[illegible]	0.88065	0.77554	0.77554	0.58065	0.8877417	0.75577
[illegible]	0.88674	0.786[illegible]	0.01107	0.52585	0.7866[illegible]E-[illegible]	0.1211
(CONSTANT)					0.5597[illegible]E-[illegible]	

H-6 (Contd.)

Area 6 – Multiple Regression Analysis F with I to R; F with B, D; B with I to R; and D with I to R

FILE F1 (CREATION DATE = [illegible])

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * * * VARIABLE LIST 1
DEPENDENT VARIABLE.. [illegible] REGRESSION LIST 2

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
I	0.54610	0.29822	0.29822	0.54610	[illegible]	[illegible]
O	0.62133	0.38[illegible]	0.08[illegible]	-0.11767	[illegible]	-0.54[illegible]
J	0.68572	0.47021	0.08417	0.1613[illegible]	[illegible]	[illegible]
K	0.72759	0.529[illegible]8	0.05917	0.20515	[illegible]034717	.34[illegible]
O	0.77[illegible]	0.60[illegible]	0.07[illegible]87	0.21137	[illegible]	.24741
L	0.79295	0.62875	0.02248	0.37662	0.11141[illegible]	.18727
[illegible]	0.80347	0.64556	0.01[illegible]	-0.16405	[illegible]4731[illegible]	[illegible]
N	0.80802	0.65219	0.00723	-0.19742	0.126[illegible]	.127[illegible]
(CONSTANT)	0.81140	0.65[illegible]7	0.00547	-0.51551	[illegible]59[illegible]	-0.12[illegible]
					-0.302495[illegible]	

H-6 (Contd.)

Area 6 - Multiple Regression Analysis F with I to R; F with B, D; B with I to R; and D with I to R

FILE F1 (CREATION DATE = [illegible])

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * * VARIABLE LIST 1

DEPENDENT VARIABLE.. [illegible] REGRESSION LIST 4

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
[illegible]	0.59830	0.357[illegible]6	0.35796	0.[illegible]	3.[illegible]	[illegible]
[illegible]	0.71253	0.50769	0.14974	[illegible]	3[illegible]	[illegible]
[illegible]	0.80727	0.65215	0.14455	[illegible]	-1.[illegible]	[illegible]
[illegible]	0.84238	0.70957	0.05693	0.[illegible]	2.[illegible]	.31321
[illegible]	0.85415	0.72964	0.02007	-0.[illegible]	[illegible]	[illegible]
[illegible]	0.86346	0.74556	0.01591	0.54784	[illegible]	[illegible]
[illegible]	0.87248	0.76121	0.01[illegible]	0.13953	-6.[illegible]	[illegible]
[illegible]	0.88786	0.78832	0.02711	0.57234	0.1[illegible]	.10471
[illegible]	0.88975	0.79166	0.00333	-0.55053	-0.277[illegible]	[illegible]
[illegible]	0.89555	0.80202	0.01036	-0.3418[illegible]	0.[illegible]	[illegible]
(CONSTANT)					-35.94823	

H-6 (Contd.)

Area 6 - Multiple Regression Analysis F with I to R; F with B, D; B with I to R; and D with I to R

FILE F1 [illegible]

MULTIPLE REGRESSION

DEPENDENT VARIABLE.. F

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
[illegible]	0.46[illegible]	0.21[illegible]	[illegible]	-0.[illegible]	[illegible]	[illegible]
[illegible]	0.52[illegible]7	0.27[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	0.[illegible]	0.47[illegible]	0.1[illegible]	0.191[illegible]	[illegible]	[illegible]
[illegible]	0.70[illegible]	0.4[illegible]1	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	0.73[illegible]	[illegible]	0.[illegible]	-0.1[illegible]	[illegible]	[illegible]
[illegible]	0.737[illegible]	0.54[illegible]9	0.[illegible]	[illegible]	[illegible]	[illegible]
I	0.739[illegible]	0.547[illegible]4	0.00[illegible]	-0.10[illegible]11	[illegible]	[illegible]
[illegible]	0.741[illegible]	0.55[illegible]	0.0[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	0.74[illegible]52	0.55[illegible]4	0.000[illegible]	0.[illegible]177[illegible]	[illegible]	[illegible]
(CONSTANT)					1.1[illegible]	

H-7

Area 7 - Multiple Regression Analysis F with I to R; F with B, D; B with I to R; and D with I to R

FILE F1 (CREATION DATE = [illegible])

* MULTIPLE REGRESSION * * * * * * * * * * * * * * * VARIABLE LIST 1
REGRESSION LIST 2

DEPENDENT VARIABLE.. F

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
[illegible]	0.877[illegible]	0.77[illegible]	0.770[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	0.[illegible]	0.77[illegible]6	0.00[illegible]	0.[illegible]	[illegible]	[illegible]
(CONSTANT)					[illegible] 572[illegible]	

H-7 (Contd.)

Area 7 - Multiple Regression Analysis F with I to R; F with B, D; B with I to R; and D with I to R

FILE F1 (CREATION DATE = [illegible])

. . . . MULTIPLE REGRESSION . . . .

DEPENDENT VARIABLE ..

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
[illegible]	0.47627	0.22683	0.22683	-0.47627	[illegible]	[illegible]
[illegible]	0.58432	0.34143	0.11460	0.30424	[illegible]	[illegible]
[illegible]	0.66900	0.44747	0.10624	-0.09500	[illegible]	[illegible]
[illegible]	0.68943	0.47530	0.02833	-0.12474	[illegible]	[illegible]
[illegible]	0.69736	0.48632	0.01041	0.27801	[illegible]	0.14171
[illegible]	0.70035	0.49050	0.00418	0.04450	[illegible]	[illegible]
[illegible]	0.70443	0.49622	0.00572	0.01228	[illegible]	[illegible]
[illegible]	0.70464	0.49652	0.00030	-0.02527	[illegible]	[illegible]
[illegible]	0.70488	0.49685	0.00034	0.35736	[illegible]	[illegible]
(CONSTANT)					[illegible]	

H-7 (Contd.)

Area 7 – Multiple Regression Analysis F with I to R; F with B, D; B with I to R; and D with I to R

FILE F1 (CREATION DATE = 06/17/83)

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * * * VARIABLE LIST 1
REGRESSION LIST 4

DEPENDENT VARIABLE.. [illegible]

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
K	0.44661	0.19946	0.19946	0.44661	[illegible]	[illegible]
[illegible]	0.62677	0.39319	0.19364	-0.411[illegible]	[illegible]	[illegible]
[illegible]	0.72681	0.52826	0.13516	0.23360	1.543[illegible]	[illegible]
[illegible]	0.76989	0.59280	0.06434	-0.04845	-0.7674[illegible]	[illegible]
I	0.79971	0.63953	0.04693	0.46955	[illegible]	[illegible]
[illegible]	0.82319	0.67764	0.03812	-0.15597	0.7697[illegible]	[illegible]
O	0.82432	0.67950	0.00185	0.40547	-0.3159[illegible]	-0.1764[illegible]
M	0.82734	0.68449	0.00499	0.39954	1.77[illegible]	[illegible]
J	0.82791	0.68543	0.00094	0.61944	1.77347	[illegible]
L	0.82809	0.68574	0.00031	0.27341	-0.[illegible]13217	-0.0277[illegible]
(CONSTANT)					8.278327	

H-7 (Contd.)

Area 7 - Multiple Regression Analysis F with I to R; F with B, D; B with I to R; and D with I to R

FILE F1 (CREATION DATE = 06/07/83)

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * * * VARIABLE LIST 1

DEPENDENT VARIABLE.. F REGRESSION LIST 1

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
I	0.25462	0.06413	0.06413	-0.25462	-0.4378[illegible]	-0.25[illegible]
R	0.31137	0.09[illegible]	0.03212	0.20259	[illegible]	0.1[illegible]
[illegible]	0.39449	0.15562	0.05867	0.16[illegible]	[illegible]	[illegible]
[illegible]	0.54657	0.29917	0.14355	-0.154[illegible]	[illegible]	-0.90546
[illegible]	0.61176	0.37425	0.07508	-0.0592[illegible]	[illegible]	-0.3[illegible]
L	0.61985	0.38426	0.01001	0.10314	[illegible]	0.1146[illegible]
J	0.62270	0.38775	0.00350	-0.20231	[illegible]	-0.09114
O	0.62564	0.39142	0.00367	0.10464	[illegible]	0.11[illegible]
[illegible]	0.62855	0.39508	0.00366	-0.06485	[illegible]	0.12[illegible]
[illegible]	0.62942	0.39616	0.00108	0.00000	[illegible]	0.05[illegible]
(CONSTANT)					[illegible]	

H-8

Area 8 - Multiple Regression Analysis F with I to R; F with B, D; B with I to R; and D with I to R

FILE F1 (CREATION DATE = [illegible])

* M U L T I P L E   R E G R E S S I O N * * * * * * * * * * * * * * VARIABLE LIST 1
REGRESSION LIST [illegible]

DEPENDENT VARIABLE.. [illegible]

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
[illegible]	0.92738	0.86004	0.86004	0.2739	[illegible]	[illegible]
[illegible]	0.94673	0.89629	0.03625	[illegible]	[illegible]	[illegible]
(CONSTANT)					.55425[illegible]-01	

H-8 (Contd.)

Area 8 – Multiple Regression Analysis F with I to R; F with B, D; B with I to R; and D with I to R

FILE F1 (CREATION DATE = [illegible])

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * * * VARIABLE LIST 1 REGRESSION LIST [illegible]

DEPENDENT VARIABLE.. [illegible]

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
I	0.40302	0.16242	0.16242	-0.40302	[illegible]	[illegible]
[illegible]	0.45851	0.21032	0.047[illegible]	[illegible]	[illegible]	[illegible]
L	0.5120[illegible]	0.26220	0.05188	[illegible]	[illegible]	[illegible]
[illegible]	0.56881	0.32355	0.06175	-0.17[illegible]	[illegible]	-1.0[illegible]
[illegible]	0.68821	0.47363	0.1500[illegible]	0.15581	[illegible]	[illegible]
P	0.72684	0.52839	0.054[illegible]	-0.05733	[illegible]	[illegible]
[illegible]	0.73729	0.54360	0.01520	0.11263	[illegible]	[illegible]
[illegible]	0.73780	0.54435	0.00075	-0.04425	[illegible]	-0.95[illegible]
(CONSTANT)					1.4710[illegible]	

H-8 (Contd.)

Area 8 - Multiple Regression Analysis F with I to R; F with B, D; B with I to R; and D with I to R

FILE F1 (CREATION DATE = [illegible])

* M U L T I P L E   R E G R E S S I O N * * * * * * * * * * * * * *   VARIABLE LIST 1

[illegible] VARIABLE .. [illegible]   [illegible] LIST 4

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	ETA
[illegible]	0.36340	0.132[illegible]	0.132[illegible]	0.[illegible]	0.[illegible]	0.3[illegible]
[illegible]	0.48152	0.23186	0.[illegible]1	0.12[illegible]7	1.[illegible]	0.3[illegible]
I	0.530[illegible]5	0.28159	0.0[illegible]	-0.[illegible]779[illegible]	-7.[illegible]	-[illegible].17[illegible]
[illegible]	0.56710	0.32160	0.04[illegible]1	-0.19[illegible]	-1.115[illegible]	-0.26[illegible]
J	0.58193	0.338[illegible]5	0.017[illegible]4	-0.16[illegible]	-10.287[illegible]	-0.1[illegible]4
K	0.58676	0.344[illegible]	0.00[illegible]4	0.2214[illegible]	2.7[illegible]	0.22[illegible]76
[illegible]	0.59712	0.35655	0.0123[illegible]	0.14351	-0.57234[illegible]3	-0.2[illegible]
[illegible]	0.59972	0.359[illegible]7	0.00312	0.33[illegible]	2.0[illegible]11	0.14737
[illegible]	0.60770	0.360[illegible]3	0.00116	-0.[illegible]	0.[illegible]0312[illegible]E-[illegible]	[illegible].06[illegible]47
(CONSTANT)					10.713[illegible]	

H-8 (Contd.)

Area 8 - Multiple Regression Analysis F with I to R; F with B, D; B with I to R; and D with I to R

MULTIPLE REGRESSION

SUMMARY TABLE

MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
[illegible]	0.11655	0.11655	-0.341[illegible]	[illegible]	[illegible]
[illegible]	0.2155[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	0.2547[illegible]	0.07857	[illegible]	[illegible]	[illegible]
0.57[illegible]	0.32150	0.03155	[illegible]	[illegible]	[illegible]
[illegible]	0.33715	0.0116[illegible]	-0.1[illegible]	[illegible]	[illegible]
[illegible]	0.34770	0.010[illegible]	0.307[illegible]	[illegible]	[illegible]
[illegible]	0.36219	0.0145[illegible]	-0.17[illegible]	[illegible]	[illegible]
[illegible]	0.36263	[illegible]	0.28[illegible]17	[illegible]	[illegible]
[illegible]	0.36511	0.0014[illegible]	0.12711	[illegible]	[illegible]
				[illegible]	

H-9

Area 9 – Multiple Regression Analysis F with I to R; F with B, D; B with I to R; and D with I to R

MULTIPLE REGRESSION

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CONSTANT					[illegible]	

H-9 (Contd.)

Area 9 - Multiple Regression Analysis F with I to R; F with B, D; B with I to R; and D with I to R

ILE F1 (CREATION DATE = [illegible])

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * * VARIABLE LIST 1
[illegible] LIST [illegible]

[illegible]ENT VARIABLE.. [illegible]

SUMMARY TABLE

[illegible]IABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
	0.27202	0.07399	0.07399	-0.27202	-0.[illegible]1824[illegible]	-0.4[illegible]
	0.34786	0.12101	0.04701	-0.064[illegible]	-0.7314[illegible]	-0.[illegible]577
	0.50800	0.25817	0.13716	0.16[illegible]	0.[illegible]7614	[illegible].271[illegible]
[illegible]	0.59997	0.35994	0.10177	0.[illegible]	0.[illegible]711[illegible]	[illegible]
	0.61327	0.37610	0.016[illegible]	0.12[illegible]	0.245[illegible]E-01	[illegible].27[illegible]
-	0.62811	0.39452	0.01841	-0.11077	-[illegible]74[illegible]7	-[illegible]
[illegible]	0.63132	0.39857	0.00405	-0.19[illegible]	-0.125[illegible]E-01	-[illegible]477
	0.63768	0.40664	0.00807	0.21[illegible]	0.753[illegible]E-01	[illegible]241[illegible]
[illegible]	0.64040	0.41011	0.00347	0.[illegible]2463	0.562504 E-01	.11[illegible]
	0.64089	0.41074	0.00062	0.23746	0.65988[illegible]E-01	[illegible].03575
(CONSTANT)					1.13[illegible]	

H-9 (Contd.)

Area 9 - Multiple Regression Analysis F with I to R; F with B, D; B with I to R; and D with I to R

FILE F1 (CREATION DATE = [illegible])

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * * VARIABLE LIST 1

DEPENDENT VARIABLE.. [illegible] REGRESSION LIST 4

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
[illegible]	0.70[illegible]	0.501[illegible]	0.[illegible]	[illegible]	4.[illegible]	[illegible]
[illegible]	[illegible].75[illegible]	0.[illegible]	0.[illegible]	0.[illegible]	[illegible]	0.3[illegible]
[illegible]	0.77947	0.60757	0.0[illegible]	-[illegible]	-[illegible]	-[illegible]
[illegible]	[illegible].78357	0.613[illegible]	[illegible]	0.[illegible]	7.[illegible]	0.1[illegible]
[illegible]	[illegible].78627	0.61[illegible]	0.00[illegible]	0.[illegible]	-1.[illegible]	-[illegible]
[illegible]	0.78[illegible]10	0.622[illegible]	0.00446	[illegible].5115[illegible]	-[illegible]17730	-[illegible]
[illegible]	[illegible].7[illegible]174	0.626[illegible]	0.[illegible]	-0.[illegible]	-[illegible]	-0.01[illegible]
[illegible]	[illegible].79254	[illegible].62812	0.0012[illegible]	-0.[illegible]	-0.[illegible]	-[illegible]
(CONSTANT)					9.[illegible]	

H-9 (Contd.)

Area 9 - Multiple Regression Analysis F with I to R; F with B, D; B with I to R; and D with I to R

FILE [illegible] [illegible] = [illegible]/17/83)

. . . . M U L T I P L E   R E G R E S S I O N . . . . [illegible] LIST 1

[illegible] [illegible] LIST 1

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
[illegible]	0.466[illegible]	0.21721	0.21721	[illegible]	[illegible]	[illegible]
[illegible]	0.48415	0.244[illegible]	0.027[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	0.52423	0.274[illegible]2	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	0.53416	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	0.55692	0.312[illegible]9	0.02713	[illegible]	[illegible]	[illegible]
[illegible]	0.56464	0.31881	0.006[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	0.56[illegible]60	0.323[illegible]3	0.00471	[illegible]	[illegible]	[illegible]
[illegible]	0.57134	0.32643	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	0.57[illegible]	0.32785	0.00142	[illegible]	[illegible]	[illegible]
(CONSTANT)					[illegible]	

H-10

Area 10 - Multiple Regression Analysis F with I to R; F with B, D; B with I to R; and D with I to R

FILE FI [illegible] DATE = [illegible]

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * * * [illegible]

DEPENDENT VARIABLE.. F

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
[illegible]	0.[illegible]711	[illegible]	0.[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	0.[illegible]245	0.[illegible]	0.04514	[illegible]	[illegible]	[illegible]
(CONSTANT)					[illegible]	

H-10 (Contd.)

Area 10 – Multiple Regression Analysis F with I to R; F with B, D; B with I to R; and D with I to R

FILE F1 (CREATION DATE = [illegible])

* M U L T I P L E   R E G R E S S I O N * * * * * * * * * * * * * * VARIABLE LIST 1
[illegible] LIST [illegible]

DEPENDENT VARIABLE..

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
L	0.49747	0.24748	[illegible]	0.49747	[illegible]	[illegible]
I	0.557[illegible]	0.32[illegible]47	0.074[illegible]	-0.1879[illegible]	-0.416[illegible]	-0.23[illegible]
R	0.60634	0.36764	0.0451[illegible]	[illegible]	[illegible]	[illegible]
Q	0.64293	0.41335	0.04571	-0.[illegible]	-0.27[illegible]-01	-0.[illegible]
J	0.65299	0.42640	0.01305	0.[illegible]	0.4[illegible]	0.14[illegible]41
O	0.65993	0.43551	0.00911	0.[illegible]	0.1951[illegible]E-01	0.1[illegible]
M	0.67325	0.45326	0.01775	0.14740	-0.136724[illegible]	-0.3[illegible]
N	0.67921	0.46133	0.0080[illegible]	-0.18519	-0.36[illegible]E-0[illegible]	-0.1[illegible]27[illegible]
P	0.68041	0.46296	0.00163	-0.00[illegible]01	0.1016[illegible]44E-01	0.0[illegible]87[illegible]
(CONSTANT)					0.673[illegible]	

H-10 (Contd.)

Area 10 – Multiple Regression Analysis F with I to R; F with B, D; B with I to R; and D with I to R

FILE F1 (CREATION DATE = [illegible])

* MULTIPLE REGRESSION * * * * * * * * * * * * * * * * VARIABLE LIST 1
REGRESSION LIST 4

DEPENDENT VARIABLE.. D

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
[illegible]	0.41759	0.17437	0.17437	0.4175[illegible]	[illegible]	[illegible]
K	0.53814	0.28960	0.11522	[illegible]	[illegible]	[illegible]
L	0.56367	0.32339	0.03379	[illegible]	[illegible]	[illegible]
J	0.58103	0.33759	0.01420	[illegible]	17.[illegible]	[illegible]
I	0.58992	0.34800	0.01041	0.11974	-4.[illegible]	[illegible]
R	0.60332	0.36039	0.01238	-0.10354	[illegible]	[illegible]
P	0.60105	0.36171	0.00082	-0.01725	[illegible]	[illegible]
(CONSTANT)					-19.55741	

H-10 (Contd.)

Area 10 - Multiple Regression Analysis F with I to R; F with B, D; B with I to R; and D with I to R

FILE F1 (CREATION DATE = 06/07/83)

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * * * VARIABLE LIST 1
REGRESSION LIST 1

DEPENDENT VARIABLE.. F

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
P	0.55419	0.30702	0.30702	-0.55419	-0.6191118E-01	-0.71331
L	0.62425	0.38969	0.08266	0.01160	-1.493320	-0.66224
J	0.68716	0.47218	0.08249	0.21987	0.8263414	1.22012
D	0.74153	0.54987	0.07769	0.27026	0.5468503E-01	0.96719
I	0.77150	0.59521	0.04534	0.09282	-0.6365335	-0.30764
G	0.78135	0.61051	0.01530	0.15188	0.9427464E-01	1.55841
R	0.81977	0.67203	0.06152	-0.00910	0.7102551E-01	0.51551
H	0.83148	0.69136	0.01933	0.48949	-0.7342721E-01	-0.16813
K	0.83213	0.69244	0.00108	0.46005	-0.5730471E-01	-0.24354
N	0.83670	0.70006	0.00762	-0.50897	0.1023445E-01	0.32013
(CONSTANT)					1.116054	

H-11

Area 11 - Multiple Regression Analysis F with I to R; F with B, D; B with I to R; and D with I to R

```
FILE    F1        (CREATION DATE = [illegible])

* * * * * * * * * * * * * * * * * * * * * * * *  M U L T I P L E   R E G R E S S I O N  * * * * * * * * * * * * * *   [illegible] LIST  1
                                                                                                                      [illegible] LIST  2
DEPENDENT VARIABLE..    F

                                              SUMMARY TABLE

VARIABLE                                 MULTIPLE R  R SQUARE  RSQ CHANGE   SIMPLE R                          BETA

D                                         0.49773    0.24773   0.24773     0.49773     [illegible]            [illegible]
[illegible]                               0.52641    0.27710   0.[illegible] [illegible] [illegible]          [illegible]
(CONSTANT)                                                                              [illegible]
```

H-11 (Contd.)

Area 11 - Multiple Regression Analysis F with I to R; F with B, D; B with I to R; and D with I to R

FILE F1 (CREATION DATE = 06/07/83)

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * * VARIABLE LIST [illegible]
REGRESSION LIST [illegible]

DEPENDENT VARIABLE..

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
[illegible]	0.27687	0.07777	0.07777	-0.27687	[illegible]	-0.24641
[illegible]	0.57396	0.32944	0.25167	0.15171	[illegible]	[illegible]
[illegible]	0.65769	0.43256	0.10313	0.12702	0.195779	[illegible]
[illegible]	0.68134	0.46423	0.03167	0.13774	[illegible]	[illegible]
[illegible]	0.74936	0.56109	0.09686	0.16450	-1.99312[illegible]	[illegible]
J	0.75937	0.59154	0.03065	0.11569	1.01[illegible]	1.40311
[illegible]	0.78213	0.61172	0.01979	0.1999[illegible]	0.7325[illegible]E-01	1.02[illegible]
[illegible]	0.79696	0.63514	0.02342	-0.27410	0.5573[illegible]E-01	1.16[illegible]
P	0.83934	0.70449	0.06935	-0.09681	-0.6454[illegible]E-01	-0.7[illegible]
I	0.85446	0.73011	0.02562	0.24118	-0.431[illegible]	[illegible]
(CONSTANT)					1.1250[illegible]	

Area 11 - Multiple Regression Analysis F with I to R; F with B, D; B with I to R; and D with I to R

* M U L T I P L E   R E G R E S S I O N *   VARIABLE LIST 1
REGRESSION LIST 4

DEPENDENT VARIABLE..   D

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R		BETA
J	0.82079	0.67370	0.67370	0.82079	16.67827	0.77081
P	0.88326	0.78121	0.10751	-0.71673	-1.605974	-[illegible]
O	0.89227	0.79615	0.01494	0.54656	[illegible]	0.16704
D	0.90463	0.81836	0.02221	0.76548	3.380[illegible]	1.91641
R	0.94764	0.89802	0.07967	-0.19445	2.674[illegible]	[illegible]
L	0.95706	0.91597	0.01795	0.73724	-25.47435	-1.41573
K	0.96493	0.93109	0.01512	0.65490	-5.645136	-0.[illegible]42
M	0.96859	0.93817	0.00708	-0.48066	0.3685224	0.35771
I	0.97361	0.94791	0.00974	0.30241	-7.979701	-0.14295
H	0.97376	0.94820	0.00030	0.65826	0.6106256	0.09429
(CONSTANT)					-4.070917	

H-11 (Contd.)

Area 11 - Multiple Regression Analysis F with I to R; F with B, D; B with I to R; and D with I to R

FILE H1 (CREATION DATE = 06/07/83)

* M U L T I P L E   R E G R E S S I O N * * * * * * * * * * * * * * *

DEPENDENT VARIABLE.. F

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
I	0.31298	0.09796	0.09796	0.31298	[illegible]	[illegible]
J	0.41471	0.17198	0.07402	0.30068	[illegible]	[illegible]
N	0.44132	0.19474	0.02276	-0.24157	[illegible]	[illegible]
K	0.46794	0.21897	0.02423	0.02273	[illegible]	- .3401
Q	0.52027	0.27068	0.05171	0.11744	[illegible]	.34427
R	0.53512	0.28635	0.01567	0.06763	[illegible]	[illegible]
L	0.53750	0.28891	0.00255	0.16122	[illegible]	[illegible]
O	0.53874	0.29024	0.00133	0.17525	[illegible]	[illegible]
(CONSTANT)					[illegible]	

H-12

Area 12 - Multiple Regression Analysis F with I to R; F with B, D; B with I to R; and D with I to R

FILE F1 (CREATION DATE = 03/07/[illegible])

* MULTIPLE REGRESSION * * * * * * * * * * * * * * [illegible]

DEPENDENT VARIABLE.. F

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R		BETA
D	0.81416	0.66[illegible]	0.[illegible]	[illegible]	[illegible]	[illegible]
B	0.83997	0.70[illegible]4	0.0[illegible]	0.72[illegible]7	[illegible]	[illegible]
(CONSTANT)					[illegible]	

H-12 (Contd.)

Area 12 - Multiple Regression Analysis F with I to R; F with B, D; B with I to R; and D with I to R

[illegible] F1 [illegible]

. . . . M U L T I P L E R E G R E S S I O N . . . .

[illegible] VARIABLE.. [illegible]

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
[illegible]	0.33636	0.11314	0.11314	[illegible]	[illegible]	[illegible]
[illegible]	0.40955	0.16773	0.05459	[illegible]	[illegible]	[illegible]
[illegible]	0.48587	0.23607	0.06834	[illegible]	[illegible]	[illegible]
[illegible]	0.52423	0.27487	0.03881	[illegible]	[illegible]	[illegible]
[illegible]	0.53444	0.28563	0.01076	[illegible]	[illegible]	[illegible]
[illegible]	0.57348	0.32888	0.04325	0.18912	[illegible]	0.3775[illegible]
I	0.58750	0.34515	0.01627	[illegible]	[illegible]	[illegible]
[illegible]	0.58907	0.34700	0.00185	[illegible]	[illegible]	[illegible]
[illegible]	0.59027	0.34842	0.00142	[illegible]	[illegible]	[illegible]
[illegible]	0.59436	0.35326	0.00484	0.23346	[illegible]	[illegible]
(CONSTANT)					[illegible]	

H-12 (Contd.)

Area 12 - Multiple Regression Analysis F with I to R; F with B, D; B with I to R; and D with I to R

FILE 1 [illegible] DATE = [illegible]

* MULTIPLE REGRESSION * * * * * * * * * * * * * * [illegible]

DEPENDENT VARIABLE .. [illegible]

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
J	0.33357	0.11127	0.11127	0.33357	[illegible]	[illegible]
[illegible]	0.44585	0.19875	0.08751	[illegible]	[illegible]	[illegible]
[illegible]	0.47380	0.22449	0.02571	[illegible]	[illegible]	[illegible]
[illegible]	0.49141	0.24149	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	0.53326	0.28436	[illegible]	[illegible]	[illegible]	[illegible]
L	0.56394	0.34049	0.05662	[illegible]	[illegible]	[illegible]
[illegible]	0.60173	0.36208	0.02110	[illegible]	[illegible]	[illegible]
I	0.61181	0.37431	0.01223	[illegible]	[illegible]	[illegible]
D	0.61217	0.37475	0.00045	[illegible]	[illegible]	[illegible]
(CONSTANT)					24.42474	

H-12 (Contd.)

Area 12 – Multiple Regression Analysis F with I to R; F with B, D; B with I to R; and D with I to R

SUMMARY TABLE

	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	0.61103	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	0.35677	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	0.41780	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	0.68217	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	0.03121	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	0.70333	[illegible]	[illegible]	-0.08117	[illegible]	[illegible]
[illegible]	0.70359	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]					[illegible]	

H-13

Area 13 – Multiple Regression Analysis F with I to R; F with B, D; B with I to R; and D with I to R

ILE [illegible]F1 (CREATION DATE = [illegible])

* M U L T I P L E   R E G R E S S I O N * * * * * * * * * * * * * * VARIABLE LIST 1
REGRESSION LIST [illegible]

DEPENDENT VARIABLE.. F

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
[illegible]	0.[illegible]4626	0.71615	0.71615	0.[illegible]46[illegible]	[illegible]434E-[illegible]	[illegible]
[illegible]	0.91973	0.84467	0.1[illegible]7[illegible]	0.76[illegible]4	0.[illegible]31[illegible]	[illegible]
(CONSTANT)					[illegible]12[illegible]7475-[illegible]	

H-13 (Contd.)

Area 13 - Multiple Regression Analysis F with I to R; F with B, D; B with I to R; and D with I to R

[illegible]

. . . . M U L T I P L E   R E G R E S S I O N . . . . [illegible] LIST 1

[illegible] LIST [illegible]

SUMMARY TABLE

[illegible]	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R		[illegible]
	0.34431	0.11[illegible]	0.11[illegible]	[illegible]	[illegible]	[illegible]
	0.3[illegible]316	0.15[illegible]7	0.[illegible]	[illegible]	[illegible]	.44[illegible]11
	0.4[illegible]	0.18635	0.[illegible]76[illegible]	-0.[illegible]531[illegible]	-0.[illegible]2814[illegible]	-[illegible]
	0.46972	0.21970	0.[illegible]51[illegible]	-[illegible]2[illegible]13	[illegible]	[illegible]
	0.51112	0.26124	0.04154	-0.[illegible]671[illegible]	-[illegible]	-[illegible]
	0.51710	0.2[illegible]7[illegible]	0.[illegible]	-0.1544[illegible]	-1.[illegible]01[illegible]	-[illegible]
	0.54266	0.2[illegible]44[illegible]	0.[illegible]27[illegible]	-0.1712[illegible]	0.[illegible]717[illegible]	[illegible]
	0.55217	0.30489	0.[illegible]104[illegible]	0.[illegible]	-0.1646[illegible]-1	-0.[illegible]44
	0.57544	0.33228	0.02740	-0.[illegible]402[illegible]	-0.14241[illegible]1	-0.[illegible]
	0.57729	0.33327	0.0005[illegible]	-0.[illegible]524	0.733[illegible]E-[illegible]1	[illegible]4162
[illegible]STANT)					1.970177	

H-13 (Contd.)

Area 13 - Multiple Regression Analysis F with I to R; F with B, D; B with I to R; and D with I to R

FILE F1 (CREATION DATE = [illegible])

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * * * VARIABLE LIST 1

DEPENDENT VARIABLE.. REGRESSION LIST 4

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R		BETA
L	0.30??	0.09??	[illegible]	-0.?0??2	-7.1[illegible]	-0.44719
R	0.39412	0.15523	0.?5476	0.26144	1.[illegible]	0.?71?7
P	0.52731	0.27806	0.12273	-0.??741	-?.1[illegible]	-?.0?8?7
N	0.56?03	0.31701	0.03895	-0.19?51	-0.[illegible]	-?.7?7?
O	0.66508	0.44233	0.12532	-0.173?5	-0.??01??	-0.53814
Q	0.70466	0.49654	0.05421	-0.14142	?.?740???	.?4??
M	0.71290	0.50872	0.01168	0.04025	-1.?6?7??	-0.202??
J	0.71559	0.51208	0.00355	0.09224	-11.?????	-?.??545
K	0.72566	0.52661	0.01453	0.11412	2.45?48?	0.32627
I	0.73008	0.53301	0.00641	0.13415	2.3??510	0.10624
(CONSTANT)					4?.?0?8?	

H-13 (Contd.)

Area 13 - Multiple Regression Analysis F with I to R; F with B, D; B with I to R; and D with I to R

FIL [illegible] (CREATION DATE = [illegible])

. . . . M U L T I P L E   R E G R E S S I O N . . . . VARIABLE LIST 1
REGRESSION LIST 1

DEPENDENT VARIABLE..

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
D	0.24766	0.06134	0.06134	0.24766	0.3567347E-01	0.[illegible]
[illegible]	0.42946	0.18445	0.12311	-0.17197	-0.[illegible]E-01	-0.59[illegible]77
K	0.49387	0.23413	0.0496[illegible]	0.10[illegible]4	0.1703027	0.[illegible]
M	0.55500	0.30802	0.073[illegible]	0.06[illegible]3	-0.236[illegible]1[illegible]	-0.53[illegible]1
J	0.56196	0.31580	0.00778	-0.[illegible]	-0.1266[illegible]	-0.12354
[illegible]	0.56622	0.32061	0.00481	0.05[illegible]	-0.1126[illegible]E-01	-0.030[illegible]
I	0.56947	0.32430	0.003[illegible]	0.00226	-0.1566[illegible]	-0.0[illegible]
L	0.57093	0.32602	0.00172	0.11982	0.[illegible]E-01	0.09544
P	0.57266	0.32817	0.00215	0.14816	0.1264561E-01	0.15214
N	0.57393	0.32939	0.00122	-0.07356	-0.372[illegible]E-02	-0.10[illegible]7
(CONSTANT)					1.30360	

H-14

Area 14 – Multiple Regression Analysis F with I to R; F with B, D; B with I to R; and D with I to R

FILE F1 (CREATION DATE = [illegible])

* M U L T I P L E   R E G R E S S I O N * * * * * * * * * * * * * * VARIABLE LIST 1
REGRESSION LIST 1

DEPENDENT VARIABLE.. F

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
I	0.83189	0.64203	0.69213	[illegible]	[illegible]	0.49[illegible]
D	0.86563	0.74931	0.05728	0.81561	0.17575[illegible]	0.41[illegible]
(CONSTANT)					-0.17[illegible]	

H-14 (Contd.)

Area 14 – Multiple Regression Analysis F with I to R; F with B, D; B with I to R; and D with I to R

. . . . M U L T I P L E   R E G R E S S I O N . . . .   [illegible]

DEPENDENT VARIABLE ..

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
[illegible]	0.13330	0.01777	0.01777	0.1333[illegible]	[illegible]	[illegible]
[illegible]	0.30020	0.09012	0.07235	0.[illegible]41[illegible]	0.10[illegible]	[illegible]
[illegible]	0.33170	0.11003	0.01991	-0.04665	-0.15[illegible]E-01	[illegible]
[illegible]	0.34739	0.12068	0.01065	0.01704	-0.15683e1	[illegible]
R	0.36063	0.13005	0.00937	-0.02918	-0.42[illegible]E-01	-0.321.1
[illegible]	0.37483	0.14049	0.01044	-0.06513	-0.31[illegible]E-01	-0.442[illegible]
J	0.39182	0.15352	0.01303	0.03627	0.2247[illegible]3	0.214[illegible]
L	0.39863	0.15890	0.00538	0.01917	-0.88047[illegible]	-0.133[illegible]
I	0.40305	0.16245	0.00354	0.0312[illegible]	-0.10075[illegible]	-0.[illegible]
D	0.40438	0.16352	0.00107	0.13167	0.[illegible]12491[illegible]	0.0[illegible]
(CONSTANT)					2.60[illegible]	

H-14 (Contd.)

Area 14 - Multiple Regression Analysis F with I to R; F with B, D; B with I to R; and D with I to R

FILE [illegible] (CREATION DATE = [illegible])

* M U L T I P L E   R E G R E S S I O N * * * * * * * * * * * * * *   VARIABLE LIST 1

DEPENDENT VARIABLE..   REGRESSION LIST 4

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
D	0.43401	0.18837	0.18837	0.43411	[illegible]	[illegible]
P	0.56063	0.31427	0.12590	0.0[illegible]	1.56534	[illegible]
K	0.62681	0.39289	0.07862	0.27073	3.172847	0.44113
V	0.65087	0.42363	0.03074	0.16932	-7.7654[illegible]	-0.745[illegible]
M	0.68802	0.47337	0.04975	-0.25744	-6.[illegible]	-0.79[illegible]
L	0.72449	0.52561	0.05223	0.29057	3.823567	0.24146
J	0.73328	0.53770	0.01209	0.[illegible]	5.[illegible]	0.1[illegible]
I	0.73808	0.54477	0.00707	0.24349	4.4[illegible]	0.10[illegible]
Q	0.73920	0.54641	0.00165	0.01529	-0.275117[illegible]	-0.155[illegible]
R	0.74008	0.54772	0.00131	-0.01663	-0.8132[illegible]	-0.06524
(CONSTANT)					37.40[illegible]4	

H-14 (Contd.)

Area 14 - Multiple Regression Analysis F with I to R; F with B, D; B with I to R; and D with I to R

FILE F1 (CREATION DATE = 06/27/33)

* M U L T I P L E   R E G R E S S I O N * * * * * * * * * * * * * [illegible] LIST 1
[illegible] LIST 1

DEPENDENT VARIABLE.. F

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
[illegible]	0.27170	0.073[illegible]2	0.07[illegible]	0.[illegible]7170	[illegible]	[illegible]1
[illegible]	0.3684[illegible]	0.1[illegible]73	0.06191	0.[illegible]3244	-0.457[illegible]	-[illegible]
J	0.38722	0.149[illegible]4	0.014[illegible]1	0.22549	[illegible]	[illegible]
[illegible]	0.41135	0.16919	0.019[illegible]	0.07309	-0.79[illegible]	-[illegible]1
I	0.42399	0.17969	0.01050	0.20[illegible]	0.11[illegible]	[illegible]
[illegible]	0.43366	0.18806	0.00837	-0.12211	[illegible]	0.14777
[illegible]	0.43473	0.18899	0.00093	-0.01463	-0.397[illegible]	-[illegible]2
(CONSTANT)					[illegible]432[illegible]	

H-15

Area 15 - Multiple Regression Analysis F with I to R; F with B, D; B with I to R; and D with I to R

FILE F1 (CREATION DATE = [illegible])

. . . . M U L T I P L E R E G R E S S I O N . . . . [illegible] LIST 1

DEPENDENT VARIABLE.. F [illegible] LIST 2

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
[illegible]	0.61497	0.37819	0.378[illegible]	0.61497	.1518[illegible]E- 1	0.42[illegible]
[illegible]	0.66851	0.446[illegible]	0.06871	0.57[illegible]	0.[illegible]2347	0.3[illegible]
(CONSTANT)					0.371[illegible]21[illegible]	

H-15 (Contd.)

Area 15 - Multiple Regression Analysis F with I to R; F with B, D; B with I to R; and D with I to R

FILE F1 (CREATION DATE = [illegible])

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * * * * * VARIABLE LIST [illegible]
REGRESSION LIST [illegible]

DEPENDENT VARIABLE.. [illegible]

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
[illegible]	0.44021	0.19379	0.19379	0.44021	[illegible]	[illegible]
[illegible]	0.52936	0.28023	0.08644	-0.[illegible]	[illegible]	[illegible]
[illegible]	0.55469	0.30768	0.02746	0.19185	[illegible]	[illegible]
[illegible]	0.59531	0.35439	0.04670	0.1[illegible]	[illegible]	[illegible]
[illegible]	0.60604	0.36728	0.01289	-0.21184	[illegible]	[illegible]
[illegible]	0.62661	0.39264	0.02535	-0.06110	[illegible]	[illegible]
[illegible]	0.63711	0.40591	0.01327	-0.1535[illegible]	[illegible]	[illegible]
[illegible]	0.65195	0.42504	0.01914	0.29979	[illegible]	[illegible]
[illegible]	0.65250	0.42575	0.00071	0.26072	[illegible]	[illegible]
(CONSTANT)					[illegible]	

H-15 (Contd.)

Area 15 - Multiple Regression Analysis F with I to R; F with B, D; B with I to R; and D with I to R

FIL F1 (CREATION DATE = 0?/07/?3)

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * * * * VARIABLE LIST 1
REGRESSION LIST 1

DEPENDENT VARIABLE..

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
L	0.23074	0.05324	0.05324	-0.23074	-6.[illegible]	-0.27711
K	0.33837	0.11445	0.061[illegible]	0.20711	4.[illegible]	[illegible]
J	0.41690	0.17381	0.059[illegible]	0.22166	13.45197	0.34[illegible]
[illegible]	0.47753	0.22814	0.05423	0.02646	[illegible]	[illegible]
I	0.49017	0.24026	0.01222	0.20[illegible]	2.131504	0.09[illegible]
[illegible]	0.49540	0.24542	0.00516	0.1679[illegible]	0.[illegible]707012	[illegible]
[illegible]	0.50004	0.25004	0.00462	0.09945	-4.[illegible]	-0.19[illegible]
R	0.50234	0.25274	0.00231	-0.05365	-0.149326[illegible]	-0.37546
O	0.50500	0.25503	0.00268	0.12921	0.128932[illegible]	[illegible]
(CONSTANT)					-4.[illegible]	

H-15 (Contd.)

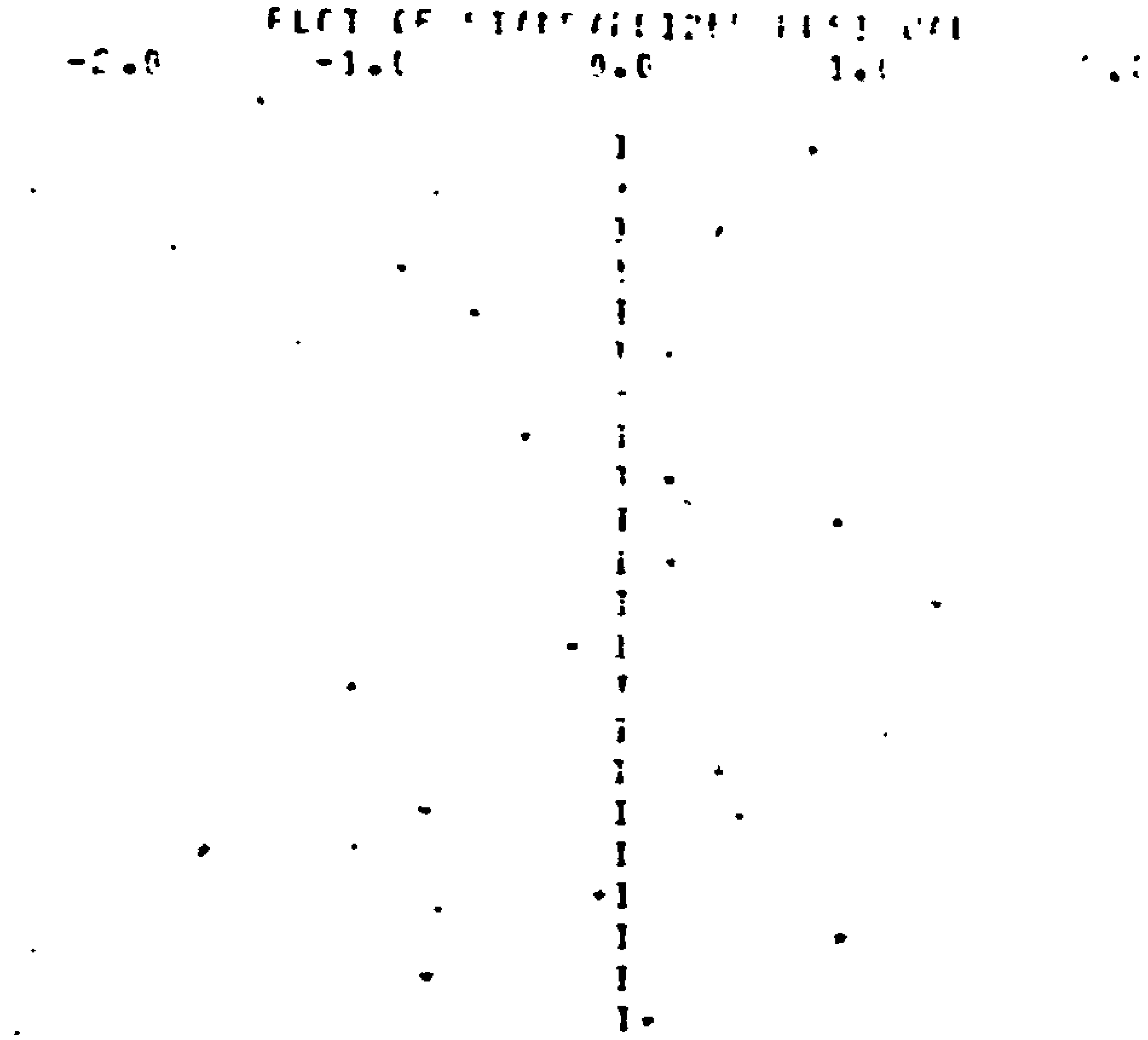
Area 15 – Multiple Regression Analysis F with I to R; F with B, D; B with I to R; and D with I to R

APPENDIX I

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * *

VARIABLE LIST 1
REGRESSION LIST 4

[illegible]	[illegible]	[illegible]	RESIDUAL
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	4.77[illegible]
4	[illegible]	11.1[illegible]	-11.18734
[illegible]	[illegible]	7.7[illegible]	-7.[illegible]452
[illegible]	[illegible]	[illegible]	1.[illegible]712
7	[illegible]	[illegible]	0.111[illegible]-11
[illegible]	[illegible]	4.4[illegible]	-4.4[illegible]72
[illegible]	[illegible]	[illegible]	2.[illegible]73
[illegible]	[illegible]	[illegible]	11.[illegible]24
11	[illegible]	[illegible]	2.13[illegible]
12	[illegible]	[illegible]	16.74[illegible]7
13	[illegible]	[illegible]	[illegible]
14	[illegible]	[illegible]	-13.4[illegible]
15	4.[illegible]	[illegible]	14.[illegible]742
[illegible]	[illegible]	[illegible]	4.744711
17	[illegible]	[illegible]	-5.[illegible]7
[illegible]	[illegible]	[illegible]1.[illegible]7	-[illegible]1.[illegible]7
[illegible]	[illegible]	[illegible]	-1.[illegible]711
[illegible]	[illegible]	[illegible]	11.1[illegible]153
21	[illegible]	[illegible]	-5.[illegible]57
[illegible]	[illegible]	[illegible]	1.213919



DURBIN-WATSON TEST OF RESIDUAL DIFFERENCES COMPARED BY CASE ORDER (SEQNUM).

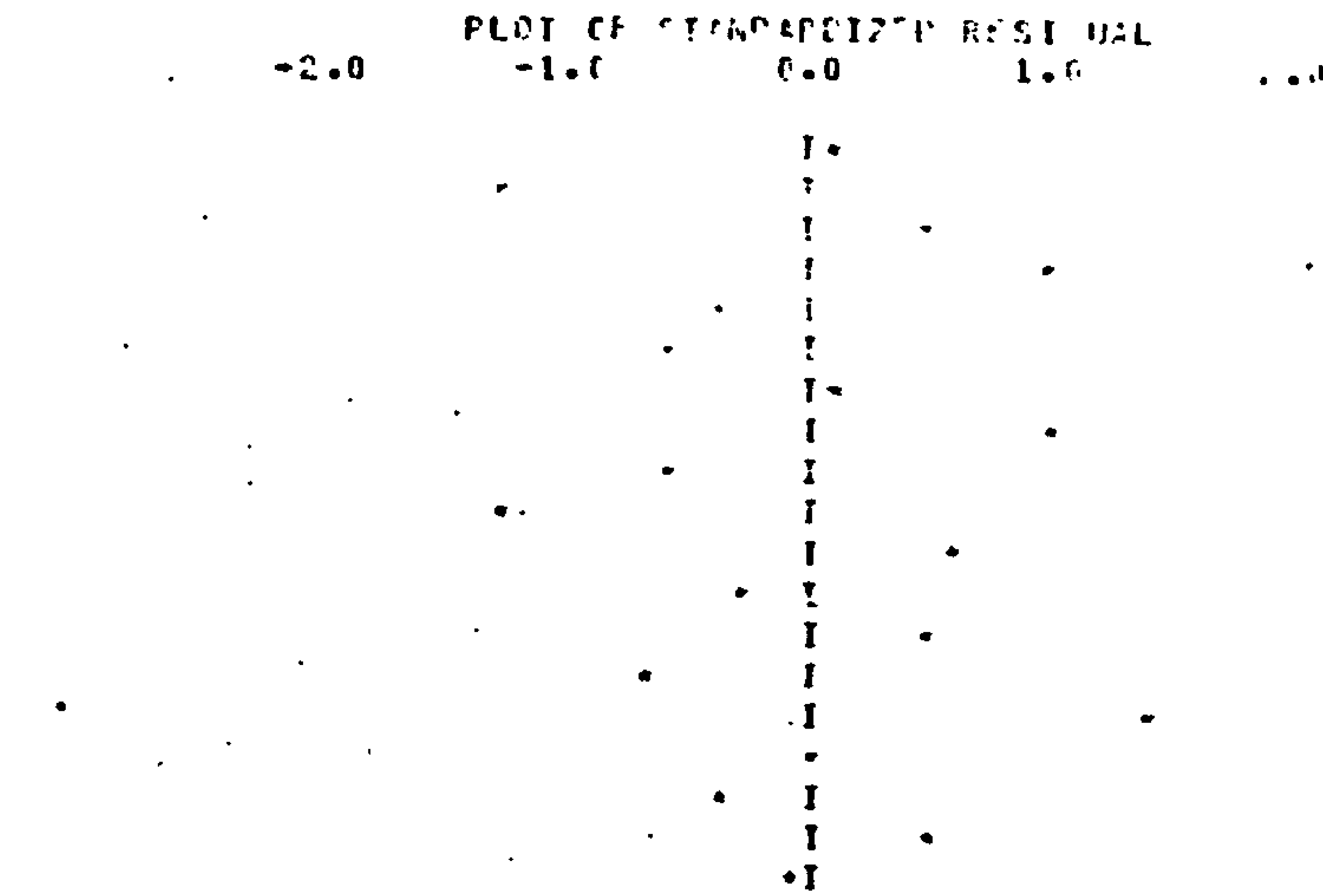
VARIABLE LIST 1, REGRESSION LIST 1.	DURBIN-WATSON TEST	1.8127[illegible]
VARIABLE LIST 1, REGRESSION LIST 2.	DURBIN-WATSON TEST	1.[illegible]7[illegible]
VARIABLE LIST 1, REGRESSION LIST 3.	DURBIN-WATSON TEST	2.03494
VARIABLE LIST 1, REGRESSION LIST 4.	DURBIN-WATSON TEST	1.[illegible]310[illegible]

I-1

Area 1 - Plot of standardised residuals and table of observed and predicted values

DEPENDENT VARIABLE: D FROM VARIABLE LIST 1
REGRESSION LIST 4

SEQNUM	OBSERVED	PREDICTED	RESIDUAL
1	[illegible]	[illegible]	1.227300
2	[illegible]	14.19638	-14.19638
3	[illegible]	[illegible]	5.487042
4	[illegible]	[illegible]	[illegible]
5	[illegible]	4.678066	[illegible]
6	[illegible]	7.012956	-7.012759
7	13.50000	12.81819	0.6818066
8	25.00000	14.10638	10.89362
9	15.00000	22.62598	-7.629978
10	15.00000	29.34864	-14.34864
11	11.50000	4.470021	7.029977
12	50.00000	53.52994	-3.529941
13	23.50000	18.13365	5.369344
14	0.0000000	7.775236	-7.775299
15	40.00000	24.29725	15.70274
16	17.00000	16.48579	0.5142124
17	0.0000000	4.719344	-4.719345
18	15.00000	[illegible]	5.641701
19	[illegible]	[illegible]	-0.5625789



DURBIN-WATSON TEST OF RESIDUAL DIFFERENCES COMPARED BY CASE ORDER (SEQNUM).

VARIABLE LIST 1, REGRESSION LIST 1. DURBIN-WATSON TEST 2.27162
VARIABLE LIST 1, REGRESSION LIST 2. DURBIN-WATSON TEST 1.70182
VARIABLE LIST 1, REGRESSION LIST 3. DURBIN-WATSON TEST 2.59983
VARIABLE LIST 1, REGRESSION LIST 4. DURBIN-WATSON TEST 2.57022

I-2

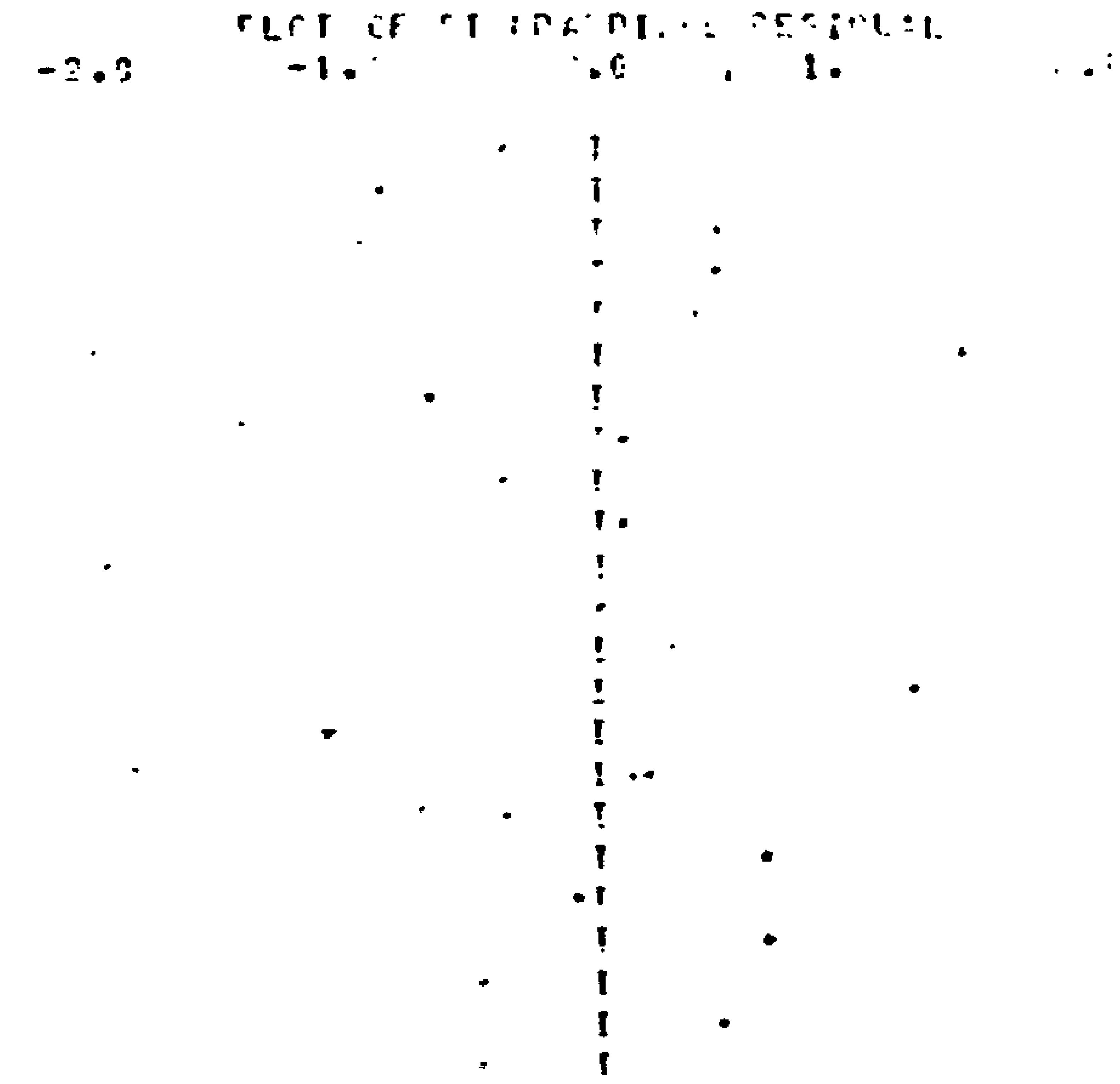
Area 2 - Plot of standardised residuals and table of observed and predicted values

* M U L T I P L E   R E G R E S S I O N * * * * * * * * * * * * * *

[illegible] FROM VARIABLE LIST 1
[illegible]GRESSION LIST 4

SEQNUM	OBSERVED	PREDICTED	RESIDUAL
1	[illegible]	21.24747	-5.247472
2	[illegible]	23.[illegible]	-11.04664
3	[illegible]	21.[illegible]	[illegible]704
4	[illegible]	11.4[illegible]	[illegible]314
5	[illegible]	25.[illegible]	4.[illegible]8744
6	[illegible]	[illegible]	18.[illegible]249
7	[illegible]	[illegible].7[illegible]7111	-8.707113
8	17.[illegible]	15.55[illegible]	1.446562
9	[illegible]	5.27[illegible]	-5.276221
10	[illegible]	-1.634912	1.634911
11	0.[illegible]	23.[illegible]247[illegible]	-23.92479
12	15.[illegible]	15.41[illegible]	-0.4123139
13	18.[illegible]	12.[illegible]	3.018538
14	17.[illegible]	1[illegible]	15.73475
15	0.[illegible]	12.[illegible]	-12.83280
16	45.[illegible]	42.212[illegible]	2.787664
17	0.[illegible]	4.849195	-4.849156
18	15.[illegible]	[illegible]	[illegible].952809
19	25.[illegible]	25.[illegible]	-[illegible].809[illegible]353
20	45.[illegible]	34.[illegible]	8.512077
21	0.000[illegible]	5.7[illegible]	-5.763909
22	[illegible]	21.44[illegible]	6.556496
23	[illegible]	[illegible]	-6.047191

PLOT OF STANDARDISED RESIDUAL



DURBIN-WATSON [illegible] RESIDUAL DIFFERENCES COMPARED BY CASE ORDER (SEQNUM).

VARIABLE LIST 1. [illegible]	[illegible] LIST 1.	DURBIN-WATSON TEST	2.[illegible]
VARIABLE LIST 1. [illegible]	[illegible] LIST 2.	DURBIN-WATSON TEST	1.75611
VARIABLE LIST 1. [illegible]	[illegible] LIST 3.	DURBIN-WATSON TEST	2.[illegible]
VARIABLE LIST 1. [illegible]	[illegible] LIST 4.	DURBIN-WATSON TEST	2.42289

I-3

Area 3 - Plot of standardised residuals and table of observed and predicted values

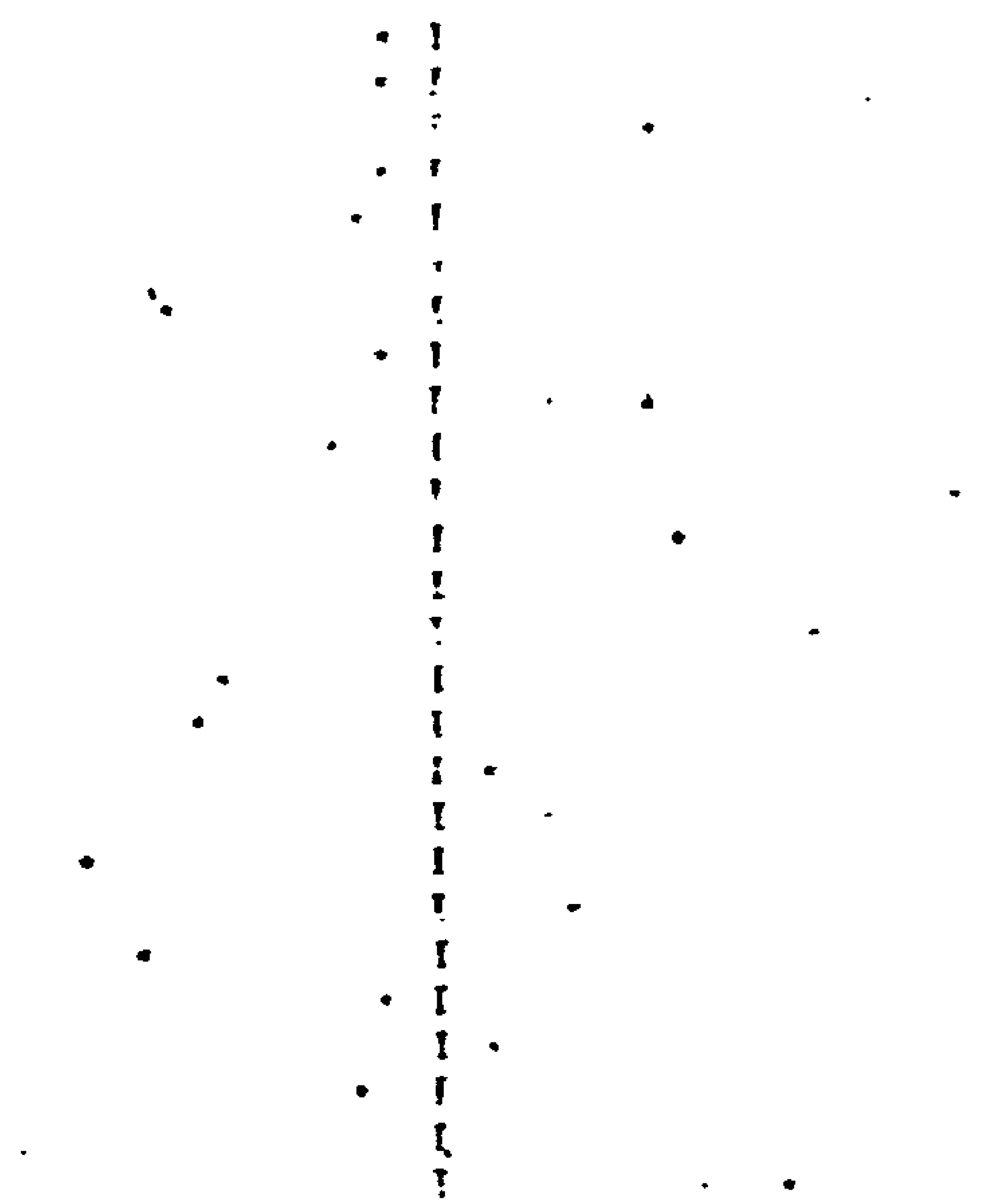
. . . . M U L T I P L E   R E G R E S S I O N . . . .

[illegible] VARIABLE [illegible]   [illegible]   VARIABLE LIST 1
REGRESSION LIST 4

SEQNUM	OBSERVED	PREDICTED	RESIDUAL
1	[illegible]	22.[illegible]	-2.61[illegible]62
[illegible]	[illegible]	[illegible]	-3.3[illegible]300
[illegible]	33.[illegible]	22.[illegible]	13.[illegible]14[illegible]
[illegible]	[illegible]	2[illegible]	-[illegible]014
[illegible]	[illegible]	20.17[illegible]1	-[illegible].17[illegible]12
[illegible]	1[illegible]	17.[illegible]117	0.4[illegible]271
7	[illegible]	14.[illegible]	-14.[illegible]7021
[illegible]	2[illegible]	23.7[illegible]	-3.755147
[illegible]	[illegible]	27.17[illegible]	12.[illegible]274[illegible]
1[illegible]	[illegible]	2[illegible]77[illegible]4	-5.879841
11	4[illegible]0000	20.[illegible]	26.67165
12	[illegible]	3[illegible]	13.7[illegible]4
13	20.[illegible]	2[illegible]	-6.957994
14	3[illegible]	14.14[illegible]	20.[illegible]5091
15	1[illegible]	31.[illegible]	-12.26969
16	0.00[illegible]	14.[illegible]	-14.52659
17	16.25[illegible]	13.72116	2.514939
18	[illegible]1.[illegible]	13.[illegible]	[illegible].742452
19	[illegible]	23.[illegible]	-[illegible]0.65996
2[illegible]	3[illegible]	22.777[illegible]	7.2[illegible]2710
21	[illegible]	17.[illegible]4[illegible]1	-17.64451
[illegible]	1[illegible]	13.[illegible]	-5.3[illegible]3498
[illegible]	1[illegible]	1[illegible]	3.1[illegible]6502
[illegible]	1[illegible]	24.[illegible]	-[illegible].3[illegible]456
25	17.[illegible]	[illegible]	-7.5[illegible]2
[illegible]	[illegible]	1[illegible]	1[illegible]0[illegible]4

PLOT OF STANDARDIZED RESIDUAL

-2.0   -1.0   0.0   1.[illegible]   [illegible]



DURBIN-WATSON TEST OF [illegible] COMPARED BY CASE ORDER (SEQNUM).

VARIABLE LIST 1, [illegible]	[illegible] LIST 1.	DURBIN-WATSON TEST	2.29253
VARIABLE LIST 1, [illegible]	[illegible] LIST 2.	DURBIN-WATSON TEST	1.65256
VARIABLE LIST 1, [illegible]	[illegible] LIST 3.	DURBIN-WATSON TEST	1.67377
VARIABLE LIST 1, [illegible]	[illegible] LIST 4.	DURBIN-WATSON TEST	2.17797

I-4

Area 4 - Plot of standardised residuals and table of observed and predicted values

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * * *

DEPENDENT VARIABLE: 5 FROM VARIABLE LIST 1
REGRESSION LIST 4

SEQNUM	OBSERVED Y	PREDICTED Y	RESIDUAL
1	21.45[illegible]	17.743[illegible]	3.706133
2	15.[illegible]	1[illegible]	4.649138
3	[illegible]	1[illegible]677	-15.50677
4	[illegible]	[illegible]7257	13.72743
5	10.[illegible]	[illegible]	-5.923065
6	[illegible]	[illegible]	-1.536945
7	[illegible]	[illegible]	-5.621578
8	18.00[illegible]	[illegible]	-0.63601548E-01
9	35.[illegible]	[illegible]12574	16.27425
10	0.0000000	14.05065	-14.05065
11	39.00000	39.00000	0.1717039E-11
12	0.0000000	[illegible]	-8.803301
13	11.[illegible]	[illegible]	2.502632
14	23.00000	11.67807	11.32192
15	[illegible]	10.79280	-2.792797
16	20.00000	10.60205	9.397949
17	10.00000	9.5[illegible]	0.4351994
18	0.0000000	7.[illegible]141	-7.396142
19	7.299[illegible]	12.77071	-5.470709
20	0.0000[illegible]	[illegible]	-5.152965
21	7.[illegible]	11.[illegible]	-4.611579
22	15.[illegible]	14.[illegible]	0.9092467
23	20.00000	1[illegible]3860	7.061402
24	15.[illegible]	14.[illegible]	0.9093467
25	12.3[illegible]	[illegible]	8.725616

PLOT OF STANDARDIZED RESIDUAL
-2.0 -1.0 0.0 1.0 2.0

DURBIN-WATSON TEST OF RESIDUAL DIFFERENCES COMPARED BY CASE ORDER (SEQNUM).

VARIABLE LIST 1,	REGRESSION LIST 1.	DURBIN-WATSON TEST	1.59782
VARIABLE LIST 1,	REGRESSION LIST 2.	DURBIN-WATSON TEST	1.73097
VARIABLE LIST 1,	REGRESSION LIST 3.	DURBIN-WATSON TEST	1.5790[illegible]
VARIABLE LIST 1,	REGRESSION LIST 4.	DURBIN-WATSON TEST	2.53014

I-5

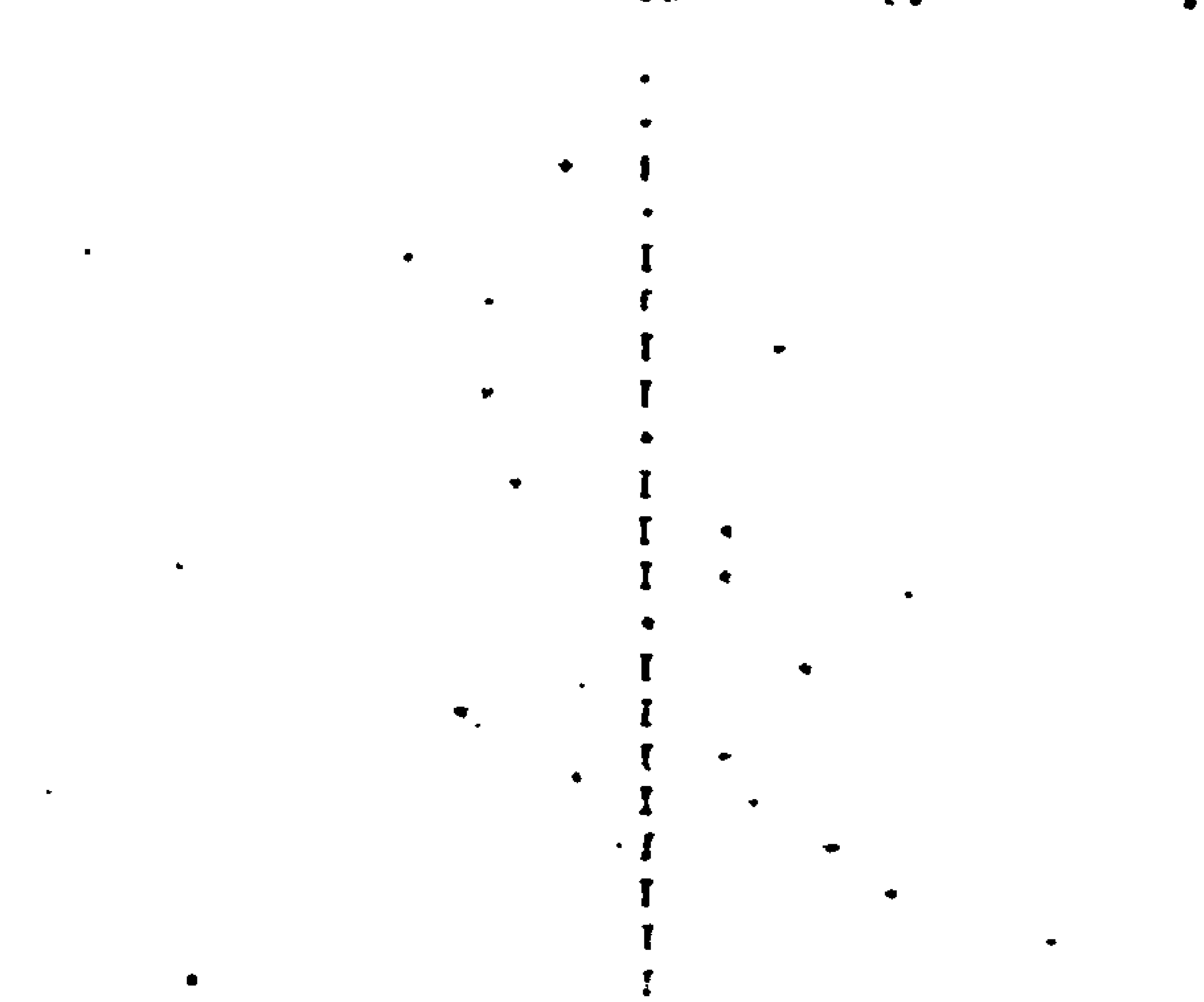
Area 5 - Plot of standardised residuals and table of observed and predicted values

. . . . M U L T I P L E   R E G R E S S I O N . . . .

DEPENDENT VARIABLE.. [illegible]   [illegible]   VARIABLE LIST 1
REGRESSION LIST 4

SEQNUM	OBSERVED	PREDICTED	RESIDUAL
1	[illegible]	[illegible].[illegible]417	-0.6417705E-01
2	[illegible]	3[illegible].10453	-0.1045515
3	[illegible]	5.423445	-2.[illegible]49
4	[illegible]	50.2[illegible]604	-0.2590442
5	1[illegible]	22.3864[illegible]	-7.366482
6	[illegible]	29.75897	-4.756973
7	1[illegible].00000	11.70619	4.093805
8	52.00000	5[illegible].74609	-4.748100
9	57.00000	56.99993	0.5319964E-11
10	27.00000	30.35019	-3.350135
11	27.00000	2[illegible].[illegible]295	3.317010
12	30.00000	27.84248	2.157522
13	50.00000	5[illegible].17992	-0.1790254
14	3[illegible].00000	31.39756	4.602436
15	42.00000	47.74726	-5.747270
16	2[illegible].50[illegible]0	2[illegible].[illegible]497	2.665025
17	35.00000	31.[illegible]687	3.473125
18	3[illegible].00000	2[illegible].74[illegible]	5.255517
19	40.00000	32.68179	7.312298
20	30.00000	1[illegible].60410	11.39589
21	[illegible]	13.55115	-13.[illegible]5119

PLOT OF STANDARDIZED RESIDUAL
-2.0 -1.0 0.0 1.0



DURBIN-WATSON TEST [illegible] DIFFERENCES COMPARED BY CASE ORDER (SEQNUM).

VARIABLE LIST 1, [illegible] LIST 1.	DURBIN-WATSON TEST	2.06597
VARIABLE LIST 1, [illegible] LIST 2.	DURBIN-WATSON TEST	2.48711
VARIABLE LIST 1, [illegible] LIST 3.	DURBIN-WATSON TEST	1.85190
VARIABLE LIST 1, [illegible] LIST 4.	DURBIN-WATSON TEST	1.87335

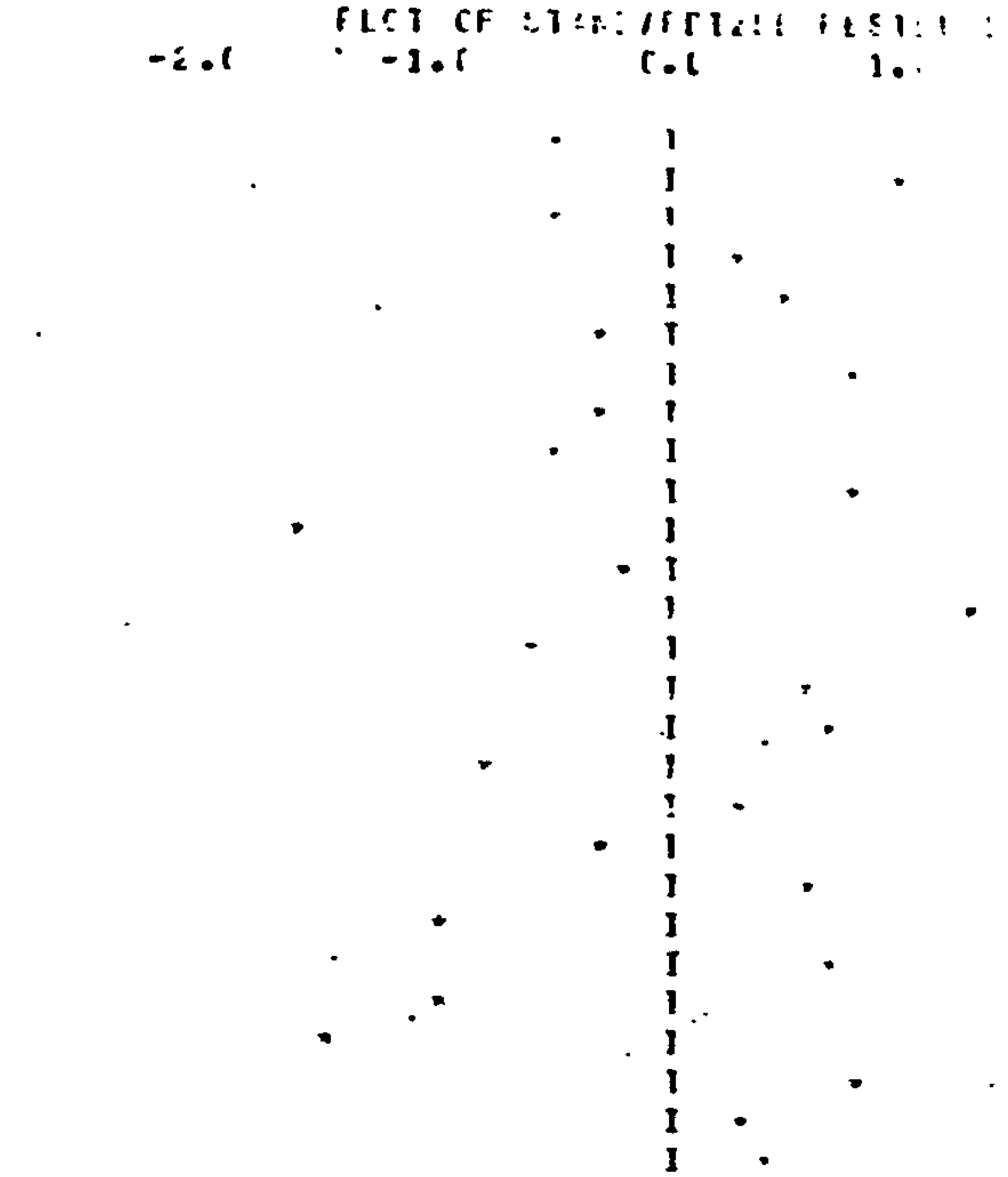
I-6

Area 6 - Plot of standardised residuals and table of observed and predicted values

. . . . MULTIPLE REGRESSION . . . .

[illegible] VARIABLE [illegible] . . . [illegible] VARIABLE LIST 1
REGRESSION LIST 4

SEQNUM	OBSERVED [illegible]	PREDICTED [illegible]	RESIDUAL
1	[illegible]	32.[illegible]	-[illegible].363723
2	61.[illegible]	49.[illegible]	11.[illegible]7
3	[illegible]	[illegible].142[illegible]	-[illegible].142[illegible]
4	1[illegible]	12.48191	5.518[illegible]
5	1[illegible].69[illegible]	7.[illegible]1318	[illegible]
6	[illegible]	[illegible].509[illegible]	-3.50913[illegible]
7	[illegible]	10.70119	[illegible].295[illegible]
8	1[illegible]	18.37798	-3.277976
9	[illegible]	18.27222	-[illegible].872219
10	[illegible]	-[illegible].267046	9.[illegible]7039
11	[illegible]	36.31124	-1[illegible].7112[illegible]
12	[illegible]	22.45857	-[illegible].358571
13	[illegible]	39.[illegible]04[illegible]	14.99[illegible]4
14	10.[illegible]	16.4[illegible]	-6.4859[illegible]7
15	[illegible]	19.490[illegible]	6.595444
16	41.[illegible]	32.[illegible]	8.076[illegible]
17	1[illegible]	1[illegible].35[illegible]11	-9.356111
18	[illegible]	24.[illegible]	[illegible]3.116734
19	[illegible]	29.41643	-2.918420
20	17.[illegible]	10.70119	6.299802
21	15.[illegible]	26.345[illegible]	-11.34586
22	4[illegible]	40.[illegible]0411	7.995962
23	12.00[illegible]0	23.79535	-11.79535
24	0.[illegible]	17.12042	-17.12043
25	15.40[illegible]	6.616095	8.781902
26	2[illegible]	16.52[illegible]	3.476553
27	3[illegible]	30.[illegible]521	4.604764



DURBIN-WATSON TEST OF RESIDUAL DIFFERENCES COMPARED BY CASE ORDER (SEQNUM).

VARIABLE LIST	1, REGRESSION LIST	1.	DURBIN-WATSON TEST	2.[illegible]6[illegible]7
VARIABLE LIST	1, REGRESSION LIST	2.	DURBIN-WATSON TEST	1.786[illegible]
VARIABLE LIST	1, REGRESSION LIST	3.	DURBIN-WATSON TEST	2.787[illegible]
VARIABLE LIST	1, REGRESSION LIST	4.	DURBIN-WATSON TEST	2.729[illegible]

I-7

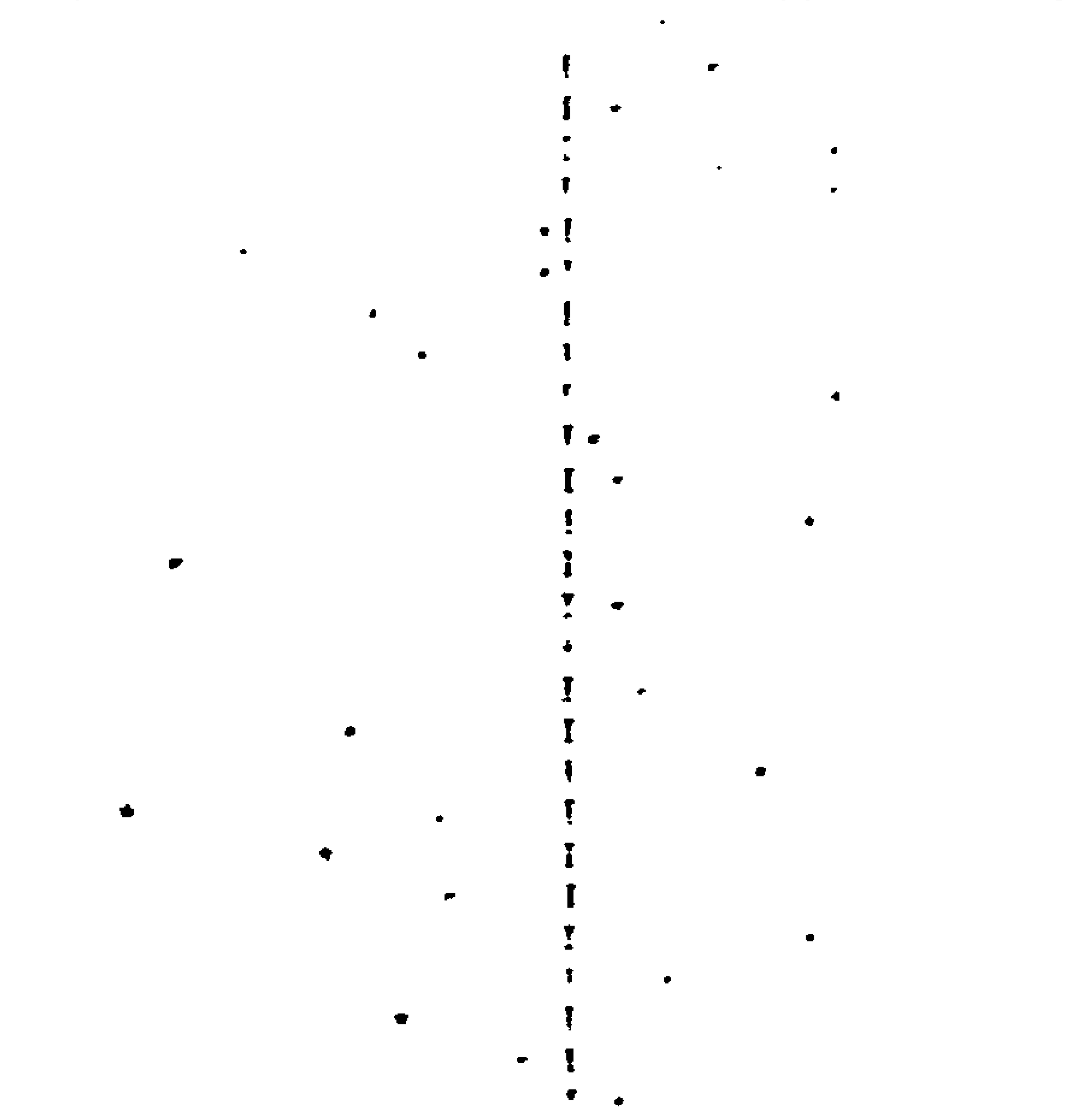
Area 7 - Plot of standardised residuals and table of observed and predicted values

* MULTIPLE REGRESSION * * * * * * * * * * * * *

[illegible] VARIABLE LIST 1
REGRESSION LIST 4

SEQNUM	OBSERVED Y	PREDICTED Y	RESIDUAL
1	[illegible]	[illegible]	1[illegible]723
2	[illegible]	1[illegible]7	[illegible].21[illegible]431
3	[illegible]	[illegible]7	22.7[illegible]62
4	[illegible]	[illegible]	32.[illegible]615
5	[illegible]	[illegible]	-[illegible]1 [illegible]73
6	[illegible].4[illegible]	[illegible]	-2.13[illegible]566
7	[illegible]	1[illegible]	-16.22460
8	1[illegible]	3[illegible]	-12.1[illegible]829
9	57.[illegible]	1[illegible].79[illegible]	22.21365
10	24.33[illegible]	[illegible]	1.460999
11	[illegible]	24.[illegible]76	[illegible].049241
12	32.[illegible]	11.41[illegible]	28.[illegible]8027
13	[illegible]	[illegible]	-33.3[illegible]609
14	17.[illegible]	12.[illegible]357	4.[illegible]64234
15	[illegible]	13.[illegible]	0.1637535E-01
16	[illegible]	[illegible].731[illegible]	[illegible].[illegible]71[illegible]
17	[illegible]	17.74[illegible]	-17.74371
18	21.[illegible]	[illegible]71	15.94913
19	[illegible]	[illegible]	-[illegible]6.1[illegible]854
20	[illegible]	[illegible]	-19.65565
21	[illegible]	1[illegible].15[illegible]	-10.19792
22	[illegible]	1[illegible].74	[illegible]5.4[illegible]594
23	[illegible]	[illegible]11	[illegible].052483
24	[illegible]	[illegible]	-14.[illegible]1576
25	[illegible]	[illegible]	-4.2[illegible]2931
26	1[illegible]	1[illegible]	4.337241

PLOT OF STANDARDIZED RESIDUAL
-2.0 -1.0 0.0 1.0 2.0



[illegible] COMPARED BY CASE ORDER (SEQNUM).

VARIABLE LIST 1,	[illegible] LIST 1.	DURBIN-WATSON TEST	2.[illegible]509[illegible]
VARIABLE LIST 1,	[illegible] LIST 2.	DURBIN-WATSON TEST	1.[illegible]9762
VARIABLE LIST 1,	[illegible] LIST 3.	DURBIN-WATSON TEST	2.21394
VARIABLE LIST 1,	[illegible] LIST 4.	DURBIN-WATSON TEST	2.06740

I-8

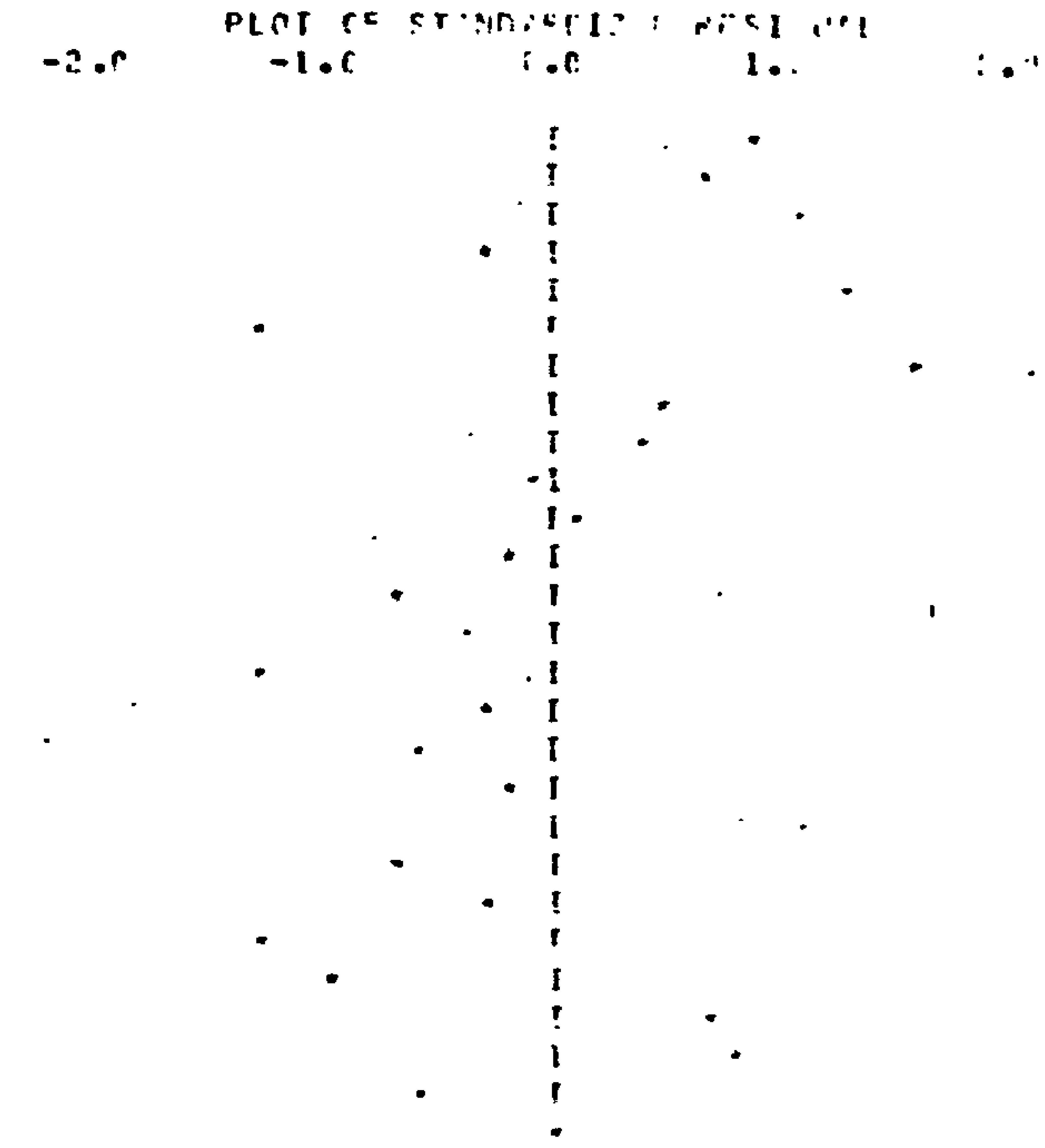
Area 8 - Plot of standardised residuals and table of observed and predicted values

MULTIPLE REGRESSION

DEPENDENT VARIABLE [illegible] VARIABLE LIST 1
REGRESSION LIST 4

SEQNUM	OBSERVED	PREDICTED	RESIDUAL
1	12.[illegible]	[illegible]	[illegible].83[illegible]298
2	2[illegible].00[illegible]	20.[illegible]	7.363869
3	[illegible]	1[illegible].[illegible]0157	11.09843
4	0.[illegible]	3.[illegible]00754	-3.320755
5	12.[illegible]	-1.[illegible]11[illegible]	13.71153
6	0.[illegible]	1[illegible].[illegible]	-13.62940
7	46.[illegible]	2[illegible].[illegible]	16.77160
8	30.[illegible]	24.[illegible]	5.668620
9	[illegible]5.[illegible]	3[illegible].[illegible]	4.116907
10	25.[illegible]	25.60475	-0.6047554
11	[illegible]	24.33697	0.6610307
12	35.[illegible]	3[illegible].[illegible]9931	-1.699011
13	0.[illegible]	[illegible].8[illegible]2[illegible]	-[illegible].862382
14	27.[illegible]	[illegible]	-4.[illegible]577[illegible]1
15	[illegible]	14.[illegible]313	-14.53313
16	[illegible]	[illegible]	-3.222354
17	18.[illegible]	24.[illegible]	-6.442682
18	[illegible]	1[illegible].[illegible]1529	-1.931953
19	37.[illegible]	[illegible].[illegible]977[illegible]	11.50224
20	[illegible]	[illegible].[illegible]57373	-6.9[illegible]7375
21	[illegible]	[illegible]	-5.[illegible]052
22	14.[illegible]	27.[illegible]	-13.[illegible]
23	1[illegible]	[illegible]	-1[illegible].[illegible]5155
24	[illegible]	1[illegible]	[illegible].992373
25	41.[illegible]	[illegible]	[illegible].59[illegible]725
26	14.[illegible]	1[illegible]	-5.9[illegible]5548
27	14.[illegible]	14.[illegible]	-0.3313376E-01

PLOT OF STANDARDIZED RESIDUAL



DURBIN-WATSON TEST [illegible] RESIDUALS COMPARED BY CASE ORDER (SEQNUM).

VARIABLE LIST 1. REGRESSION LIST 1.	DURBIN-WATSON TEST	1.98097
VARIABLE LIST 1. REGRESSION LIST 2.	DURBIN-WATSON TEST	1.09012
VARIABLE LIST 1. REGRESSION LIST 3.	DURBIN-WATSON TEST	1.86640
VARIABLE LIST 1. REGRESSION LIST 4.	DURBIN-WATSON TEST	1.55556

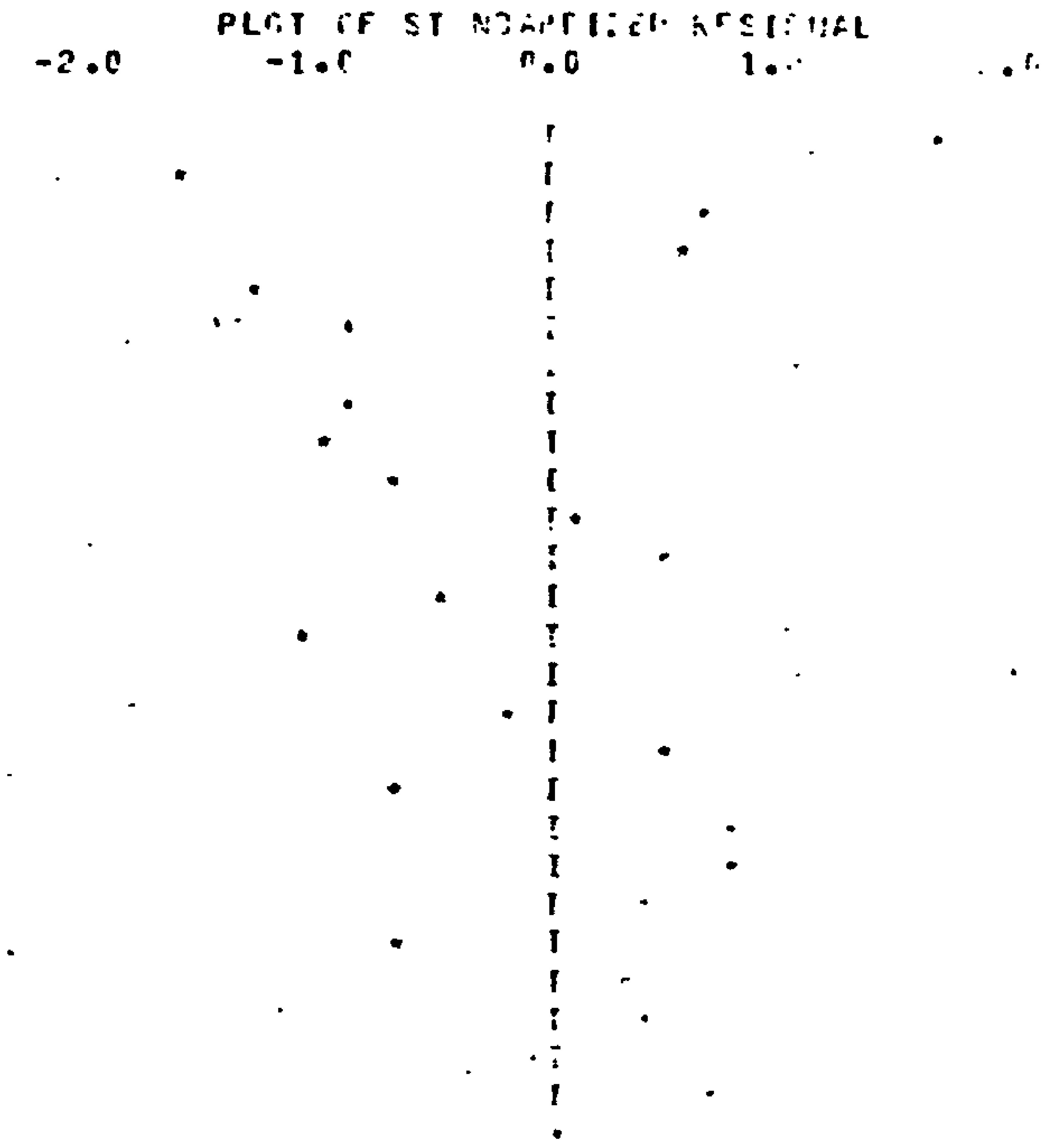
I-9

Area 9 - Plot of standarised residuals and table of observed and predicted values

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * * *

DEPENDENT VARIABLE.. FROM VARIABLE LIST 1
REGRESSION LIST 4

SEQNUM	OBSERVED Y	PREDICTED	RESIDUAL
1	50.00000	20.75340	29.24660
2	0.000000	26.73494	-26.73494
3	30.00000	17.54580	12.45420
4	30.00000	19.95163	10.04837
5	0.000000	21.94678	-21.94678
6	0.000000	14.60709	-14.60709
7	25.00000	7.257756	17.74244
8	9.000000	24.78553	-15.78553
9	0.000000	17.15432	-17.15432
10	0.000000	11.41385	-11.41385
11	50.00000	48.53474	1.465249
12	55.00000	46.07821	8.921787
13	0.000000	8.070687	-8.070671
14	0.000000	18.17777	-18.17778
15	32.00000	14.16452	17.83548
16	0.000000	4.139436	-4.139438
17	25.00000	16.43735	8.562645
18	0.000000	11.50718	-11.50718
19	33.00000	19.65282	13.34718
20	30.00000	16.03151	13.96849
21	25.00000	17.91475	7.085247
22	0.000000	12.47821	-12.47822
23	11.00000	6.425071	4.574929
24	22.00000	14.82754	7.172462
25	35.00000	36.46525	-1.465249
26	30.00000	17.84639	12.15361
27	5.000000	5.835060	-0.8353710



DURBIN-WATSON TEST OF RESIDUAL DIFFERENCES COMPARED BY CASE ORDER (SEQNUM).

VARIABLE LIST 1, REGRESSION LIST 1. DURBIN-WATSON TEST 2.35548
VARIABLE LIST 1, REGRESSION LIST 2. DURBIN-WATSON TEST 2.22054
VARIABLE LIST 1, REGRESSION LIST 3. DURBIN-WATSON TEST 2.50320
VARIABLE LIST 1, REGRESSION LIST 4. DURBIN-WATSON TEST 2.38233

I-10

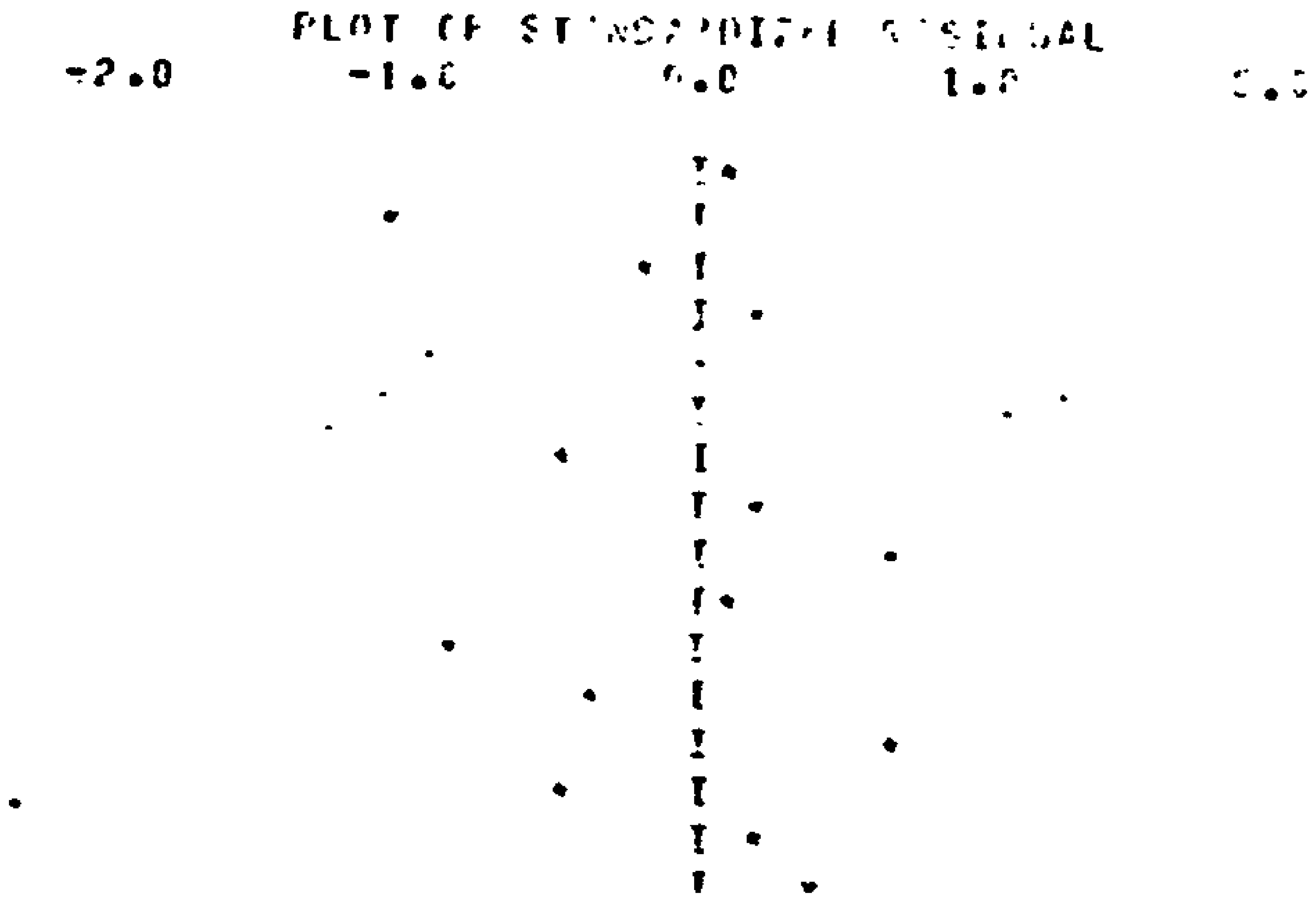
Area 10 – Plot of standardised residuals and table of observed and predicted values

. . . . M U L T I P L E R E G R E S S I O N . . . .

DEPENDENT VARIABLE: [illegible] VARIABLE LIST 1
REGRESSION LIST 4

SEQNUM	OBSERVED	PREDICTED	RESIDUAL
1	58.[illegible]	[illegible].35729	[illegible].3421742
2	7.000000	11.10468	-[illegible]
3	4.000000	5.[illegible]521	-1.175525
4	71.000000	[illegible].72742	1.272063
5	[illegible]	2[illegible].27136	0.1294593
6	[illegible]	11.[illegible]	[illegible].134597
7	20.000000	23.[illegible]5546	-3.635458
8	24.000000	2[illegible].[illegible]0248	1.1[illegible]7520
9	16.000000	11.27622	4.[illegible]23778
10	18.000000	17.26872	0.7[illegible]2828
11	36.000000	42.[illegible]	-6.[illegible]91298
12	0.0000000	[illegible].21493[illegible]	-3.214986
13	42.000000	37.[illegible]4762	4.[illegible]52376
14	27.000000	30.[illegible]54[illegible]1	-3.554013
15	33.000000	31.[illegible]7935	1.520669
16	13.000000	14.[illegible]	[illegible].094742

PLOT OF STANDARDIZED RESIDUAL



DURBIN-WATSON TEST OF RESIDUAL DIFFERENCES COMPARED BY CASE ORDER (SEGNUM).

VARIABLE LIST	1,	REGRESSION LIST	1.	DURBIN-WATSON TEST 1.75669
VARIABLE LIST	1,	REGRESSION LIST	2.	DURBIN-WATSON TEST 2.24355
VARIABLE LIST	1,	REGRESSION LIST	3.	DURBIN-WATSON TEST 2.01076
VARIABLE LIST	1,	REGRESSION LIST	4.	DURBIN-WATSON TEST 2.23011

I-11

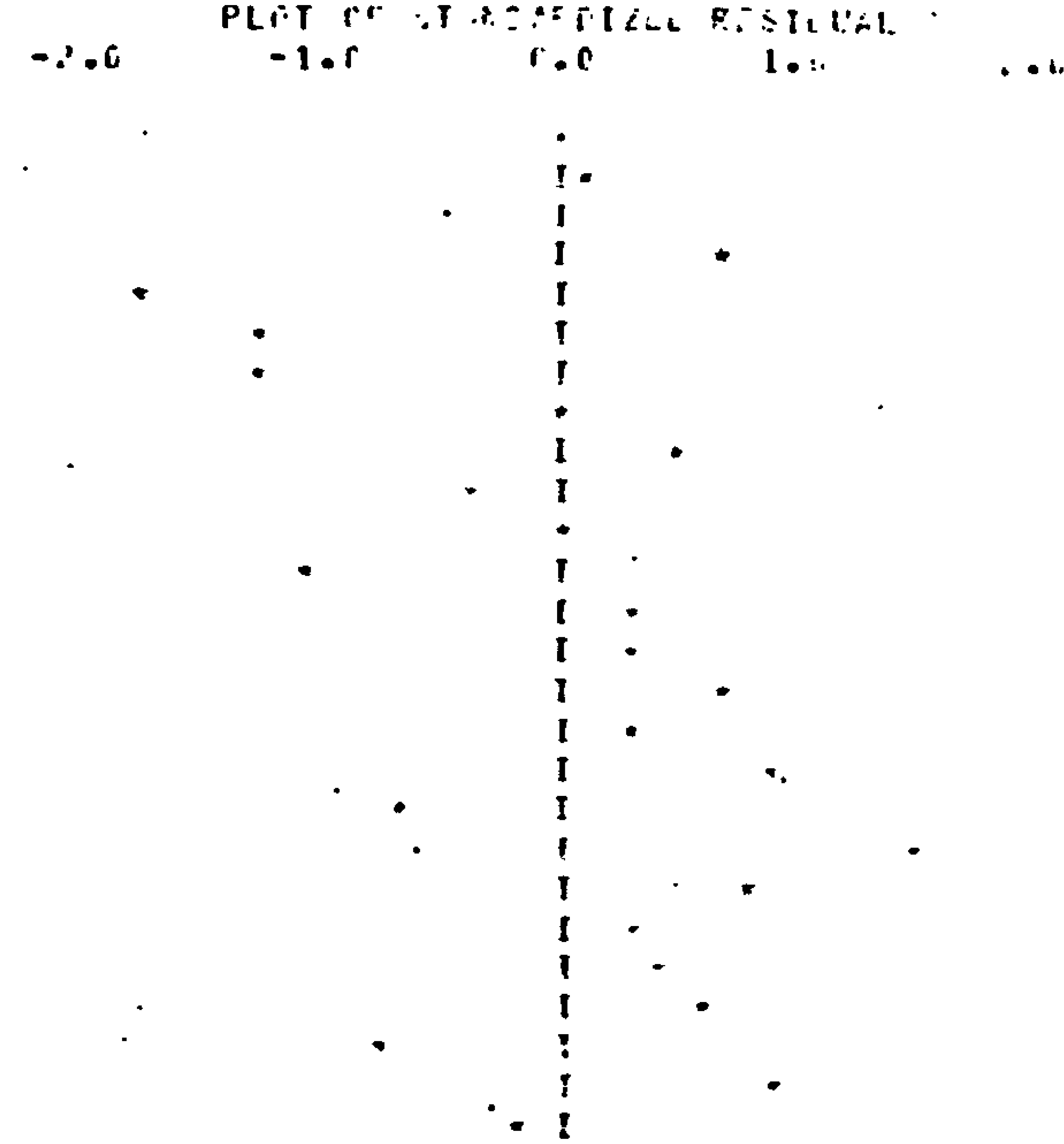
Area 11 - Plot of standardised residuals and table of observed and predicted values

* M U L T I P L E   R E G R E S S I O N * * * * * * * * * * * * * * *

DEPENDENT VARIABLE.. [illegible]   FROM   VARIABLE LIST 1
REGRESSION LIST 4

SEQNUM	OBSERVED Y	PREDICTED Y	RESIDUAL
1	[illegible]	20.[illegible]	-3.4[illegible]704
2	34.10000	25.11179	8.9882095
3	27.00000	35.13552	-8.135529
4	45.00000	35.14133	9.858692
5	0.0000000	27.92296	-27.92296
6	0.0000000	19.11736	-19.11736
7	20.00000	39.60674	-19.60674
8	46.00000	45.59950	0.4004902
9	59.00000	51.37283	7.627170
10	34.00000	40.51079	-6.510785
11	41.00000	40.69562	0.3043768
12	24.00000	41.40956	-17.40956
13	32.00000	27.54218	4.457819
14	25.50000	21.16633	4.333673
15	35.00000	24.18857	10.81143
16	35.00000	30.62676	4.373242
17	39.00000	25.66661	13.33339
18	0.0000000	19.03421	-19.03421
19	[illegible]	34.79755	23.28243
20	41.00000	29.56735	11.43265
21	30.00000	24.71353	5.286465
22	32.00000	26.31[illegible]	5.[illegible]9145
23	22.00000	13.57114	8.428855
24	0.0000000	11.88421	-11.88422
25	37.00000	23.85726	13.14274
26	25.00000	27.[illegible]	-2.38[illegible]219

PLOT OF STANDARDIZED RESIDUAL



DURBIN-WATSON TEST OF RESIDUAL DIFFERENCES, COMPARED BY CASE ORDER (SEQNUM).

VARIABLE LIST 1,	REGRESSION LIST 1.	DURBIN-WATSON TEST	2.11187
VARIABLE LIST 1,	REGRESSION LIST 2.	DURBIN-WATSON TEST	2.54742
VARIABLE LIST 1,	REGRESSION LIST 3.	DURBIN-WATSON TEST	1.69624
VARIABLE LIST 1,	REGRESSION LIST 4.	DURBIN-WATSON TEST	1.82000

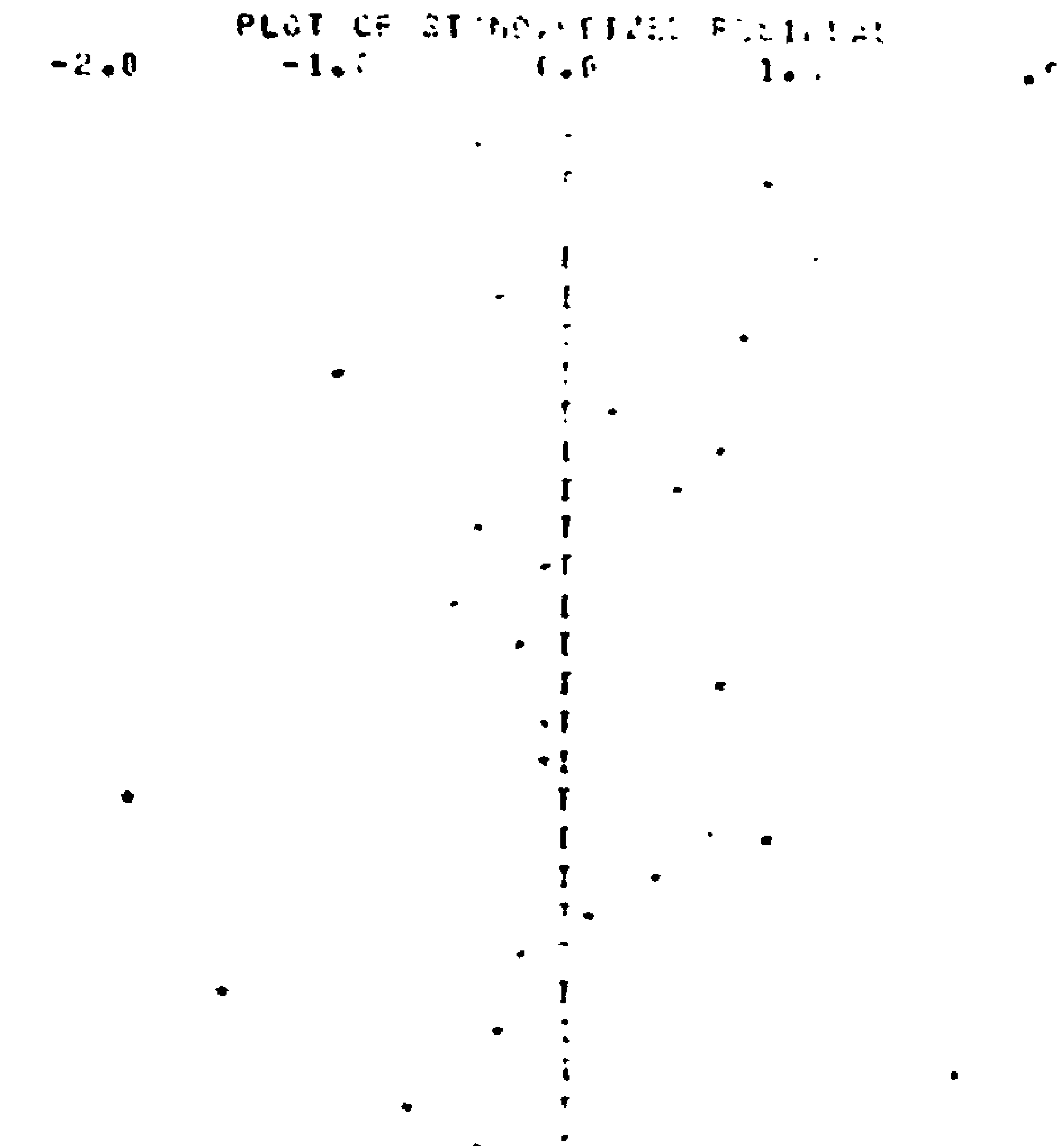
I-12

Area 12 - Plot of standardised residuals and table of observed and predicted values

* MULTIPLE REGRESSION * * * * * * * * * * * * * * *

[illegible] VARIABLE LIST 1
REGRESSION LIST 4

SEQNUM	[illegible]	[illegible]	RESIDUAL
1	[illegible]	[illegible]	[illegible]
2	[illegible]	[illegible]	[illegible]
3	[illegible]	[illegible]	[illegible]
4	[illegible]	[illegible]	[illegible]
5	[illegible]	[illegible]	[illegible]
6	[illegible]	[illegible]	[illegible]
7	[illegible]	[illegible]	[illegible]
8	[illegible]	[illegible]	1.911355
9	[illegible]	[illegible]	[illegible]
10	[illegible]	[illegible]	[illegible]
11	[illegible]	[illegible]	[illegible]
12	[illegible]	[illegible]	[illegible]
13	[illegible]	[illegible]	[illegible]
14	[illegible]	[illegible]	[illegible]
15	[illegible]	[illegible]	[illegible]
16	[illegible]	[illegible]	[illegible]
17	[illegible]	[illegible]	[illegible]
18	[illegible]	[illegible]	[illegible]
19	[illegible]	[illegible]	[illegible]
20	[illegible]	[illegible]	[illegible]
21	[illegible]	[illegible]	[illegible]
22	[illegible]	[illegible]	[illegible]
23	[illegible]	[illegible]	[illegible]
24	[illegible]	[illegible]	[illegible]
25	[illegible]	[illegible]	[illegible]
26	[illegible]	[illegible]	[illegible]
27	[illegible]	[illegible]	[illegible]



[illegible] BY CASE ORDER (SEQNUM).

VARIABLE LIST 1, [illegible] WATSON TEST 2.01449
VARIABLE LIST 1, [illegible] WATSON TEST 1.?5457
VARIABLE LIST 1, [illegible] WATSON TEST 1.77???
VARIABLE LIST 1, [illegible] WATSON TEST 2.4053?

I-13

Area 13 - Plot of standardised residuals and table of observed and predicted values

* M U L T I P L E   R E G R E S S I O N * * * * * * * * * * * * * * *

DEPENDENT VARIABLE.. [illegible]   FROM   VARIABLE LIST 1
REGRESSION LIST 4

SEQNUM	OBSERVED Y	PREDICTED Y	RESIDUAL
1	[illegible]	[illegible]	[illegible]
2	[illegible]	[illegible]	[illegible]
3	[illegible]	[illegible]	[illegible]
4	[illegible]	[illegible]	[illegible]
5	[illegible]	[illegible]	[illegible]
6	[illegible]	[illegible]	[illegible]
7	[illegible]	[illegible]	13.14407
8	[illegible]	[illegible]	-7.274435
9	[illegible]	29.01627	[illegible]
10	[illegible]	[illegible]	[illegible]
11	[illegible]	[illegible]	[illegible]
12	[illegible]	[illegible]	[illegible]
13	[illegible]	[illegible]	[illegible]
14	[illegible]	[illegible]	[illegible]
15	[illegible]	[illegible]	[illegible]
16	[illegible]	[illegible]	[illegible]
17	[illegible]	[illegible]	-6.122187
18	[illegible]	[illegible]	[illegible]
19	[illegible]	[illegible]	[illegible]
20	[illegible]	[illegible]	[illegible]
21	[illegible]	[illegible]	-15.55046
22	[illegible]	[illegible]	[illegible]
23	[illegible]	[illegible]	[illegible]
24	[illegible]	[illegible]	[illegible]
25	[illegible]	[illegible]	-10.10332
26	[illegible]	[illegible]	13.20015

DURBIN-WATSON TEST OF RESIDUAL DIFFERENCES COMPARED BY CASE ORDER (SEQNUM).

VARIABLE LIST 1, REGRESSION LIST 1. DURBIN-WATSON TEST 2.02456
VARIABLE LIST 1, REGRESSION LIST 2. DURBIN-WATSON TEST 2.42361
VARIABLE LIST 1, REGRESSION LIST 3. DURBIN-WATSON TEST 1.78564
VARIABLE LIST 1, REGRESSION LIST 4. DURBIN-WATSON TEST 1.7747[illegible]

I-14

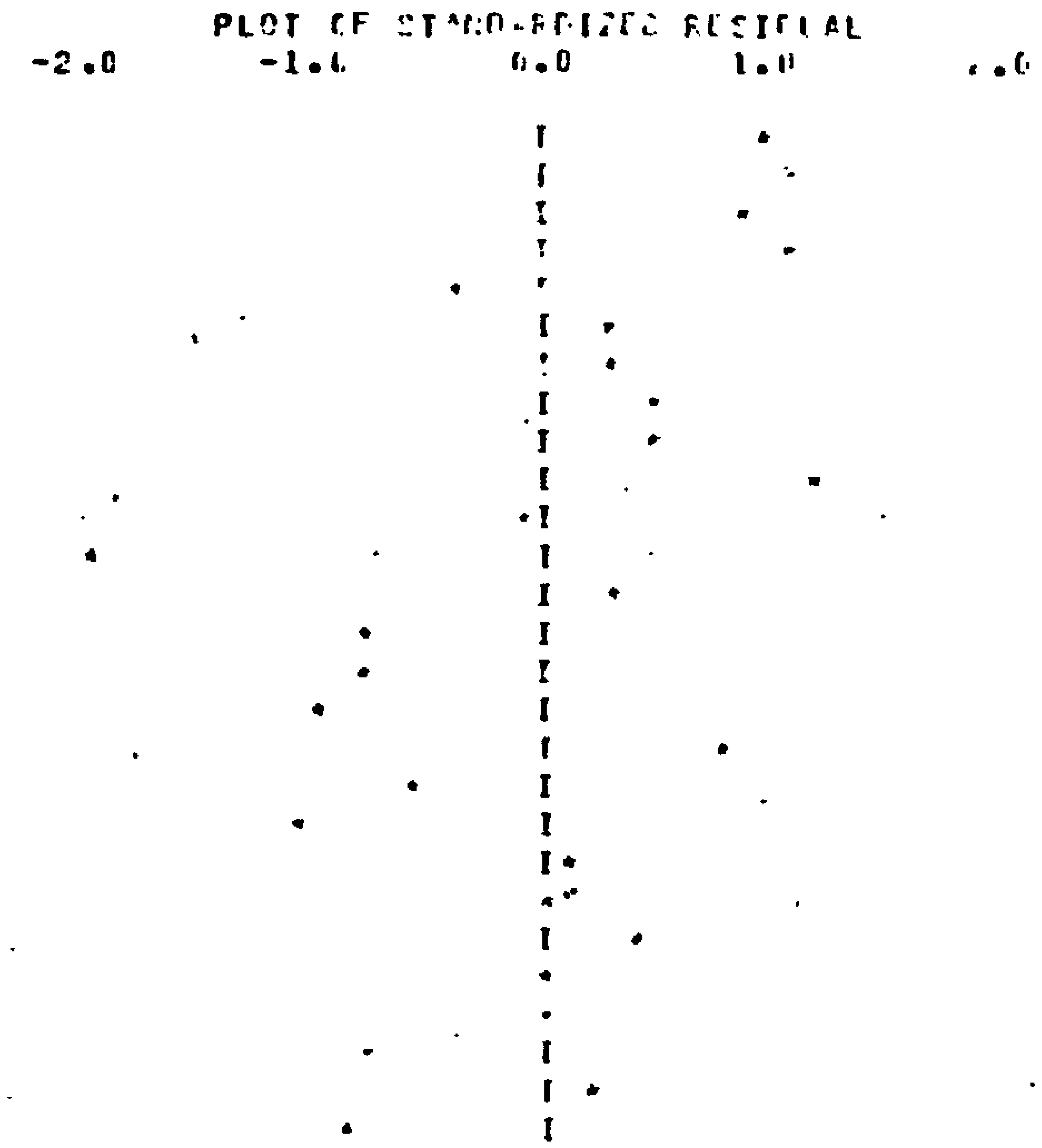
Area 14 - Plot of standardised residuals and table of observed and predicted values

TEXT BOUND
INTO
THE SPINE

. . . . M U L T I P L E   R E G R E S S I O N . . . .

DEPENDENT VARIABLE: 0   FROM   VARIABLE LIST 1
                                      REGRESSION LIST 4

SEGNUM	OBSERVED Y	PREDICTED Y	RESIDUAL
1	28.00000	17.26347	11.23653
2	34.00000	22.03704	11.96296
3	27.00000	16.41351	10.58648
4	37.00000	24.68486	12.31514
5	7.500000	12.40582	-4.905825
6	20.00000	16.75125	3.248748
7	18.00000	14.92112	3.078878
8	12.00000	6.631237	5.368760
9	25.00000	19.04723	5.952771
10	37.50000	23.98300	13.51700
11	18.00000	19.51065	-1.510647
12	0.0000000	23.00076	-23.00077
13	20.00000	17.03162	2.968377
14	10.00000	19.10049	-9.100492
15	11.50000	20.23814	-8.738144
16	10.00000	21.64215	-11.64215
17	40.50000	31.23265	9.267347
18	23.00000	29.54472	-6.544725
19	0.0000000	12.40582	-12.40582
20	23.00000	22.07133	0.9286613
21	22.00000	21.64215	0.3578494
22	27.00000	22.25069	4.749308
23	27.00000	27.20238	-0.2023775
24	20.00000	19.51065	0.4893530
25	15.00000	24.26735	-9.267349
26	18.00000	16.02259	1.977407
27	10.00000	20.68728	-10.68728



DURBIN-WATSON TEST OF RESIDUAL DIFFERENCES COMPARED BY CASE ORDER (SEGNUM).

VARIABLE LIST 1.	REGRESSION LIST 1.	DURBIN-WATSON TEST	1.95718
VARIABLE LIST 1.	REGRESSION LIST 2.	DURBIN-WATSON TEST	2.56031
VARIABLE LIST 1.	REGRESSION LIST 3.	DURBIN-WATSON TEST	1.75668
VARIABLE LIST 1.	REGRESSION LIST 4.	DURBIN-WATSON TEST	1.50893

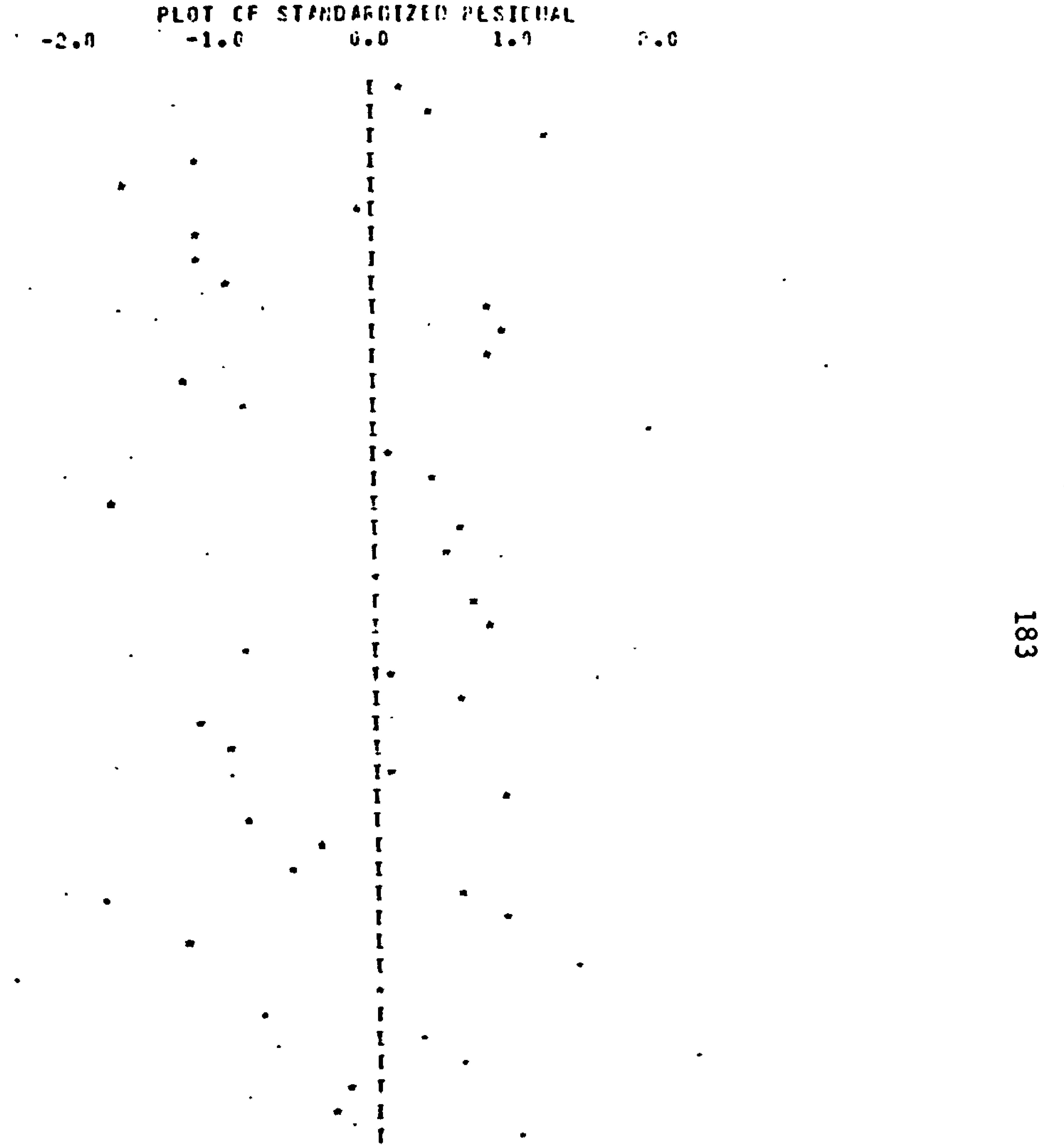
I-15

Area 15 - Plot of standardised residuals and table of observed and predicted values

• M U L T I P L E   R E G R E S S I O N • • • • • • • • • • • • • • • • • •

DEPENDENT VARIABLE: D   FROM VARIABLE LIST 1
REGRESSION LIST 4

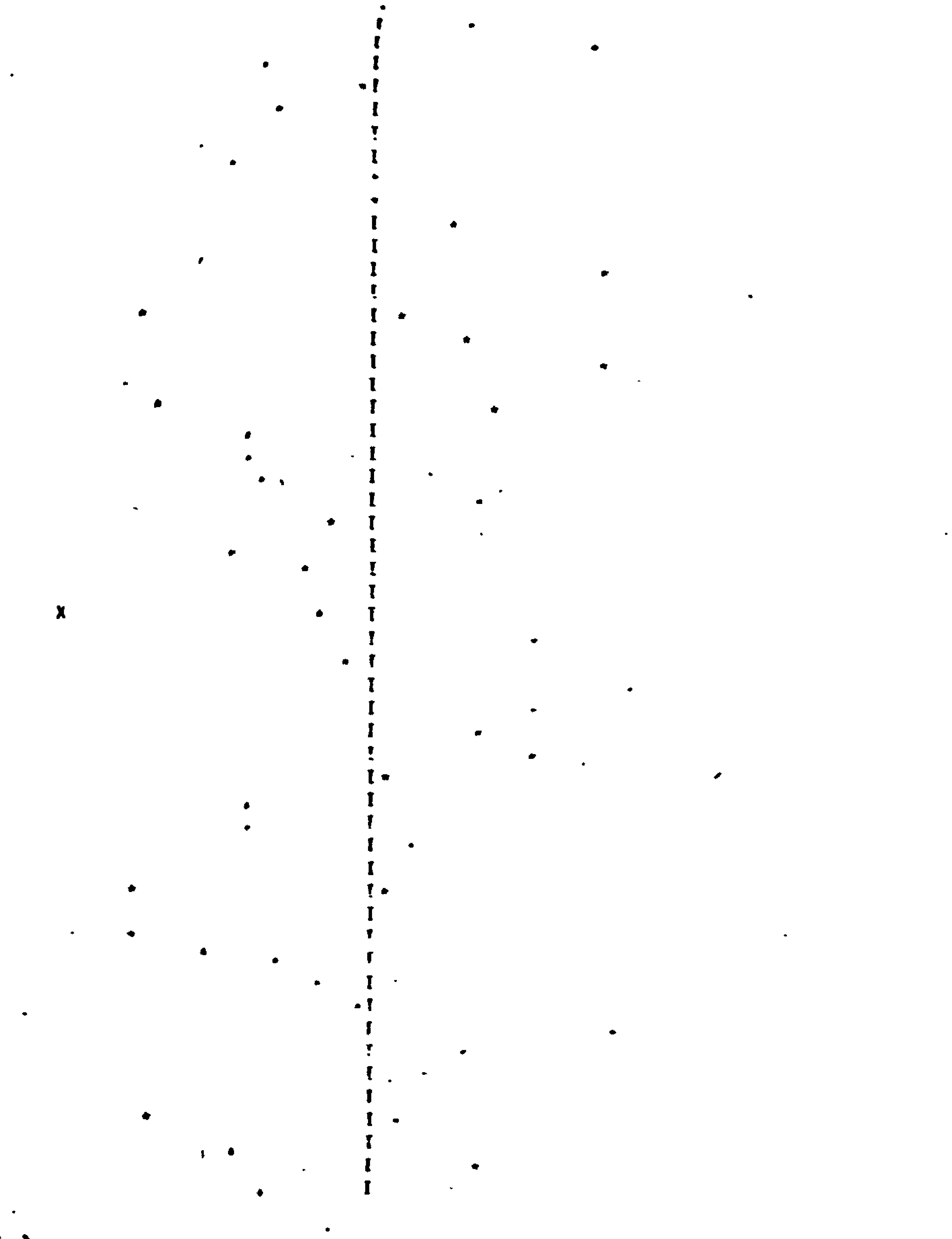
SEQNUM	OBSERVED D	PREDICTED D	RESIDUAL
1	20.00000	17.89629	2.103709
2	23.00000	17.88039	5.119612
3	40.00000	23.46481	16.53519
4	0.0000000	16.07949	-16.07950
5	0.0000000	23.05465	-23.05465
6	20.00000	22.03473	-2.034727
7	15.00000	31.32627	-16.32627
8	0.0000000	15.97099	-15.97099
9	0.0000000	13.41248	-13.41248
10	25.00000	13.71767	11.28233
11	35.00000	22.66356	12.33644
12	35.00000	24.36865	10.63134
13	0.0000000	17.22592	-17.22593
14	0.0000000	12.80054	-12.80054
15	40.00000	14.40974	25.59026
16	25.00000	23.35332	1.646676
17	20.00000	14.45610	5.543895
18	0.0000000	24.61471	-24.61472
19	30.00000	21.38349	8.616508
20	20.00000	13.43538	6.564616
21	15.00000	14.35464	0.6453557
22	30.00000	20.98009	9.019905
23	34.25000	23.72762	10.52238
24	0.0000000	12.80054	-12.80054
25	12.50000	11.30531	1.194692
26	34.00000	25.49464	8.505354
27	0.0000000	16.07949	-16.07950
28	0.0000000	13.94942	-13.94942
29	13.50000	12.09216	1.407836
30	25.00000	12.80054	12.19946
31	15.00000	27.62646	-12.62646
32	15.00000	20.26762	-5.267625
33	11.50000	20.13394	-8.633944
34	30.00000	22.31498	7.685015
35	23.50000	11.76949	11.73050
36	0.0000000	17.78551	-17.78551
37	40.00000	20.92868	19.07132
38	17.00000	17.32290	-0.3228956
39	0.0000000	11.37881	-11.37881
40	15.00000	11.01326	3.986738
41	37.50000	29.22561	8.274391
42	16.00000	18.48296	-2.482960
43	12.00000	15.79600	-3.796000
44	28.00000	14.47603	13.52397



I-16

Plot of standardised residuals and table of observed and predicted values for total data matrix

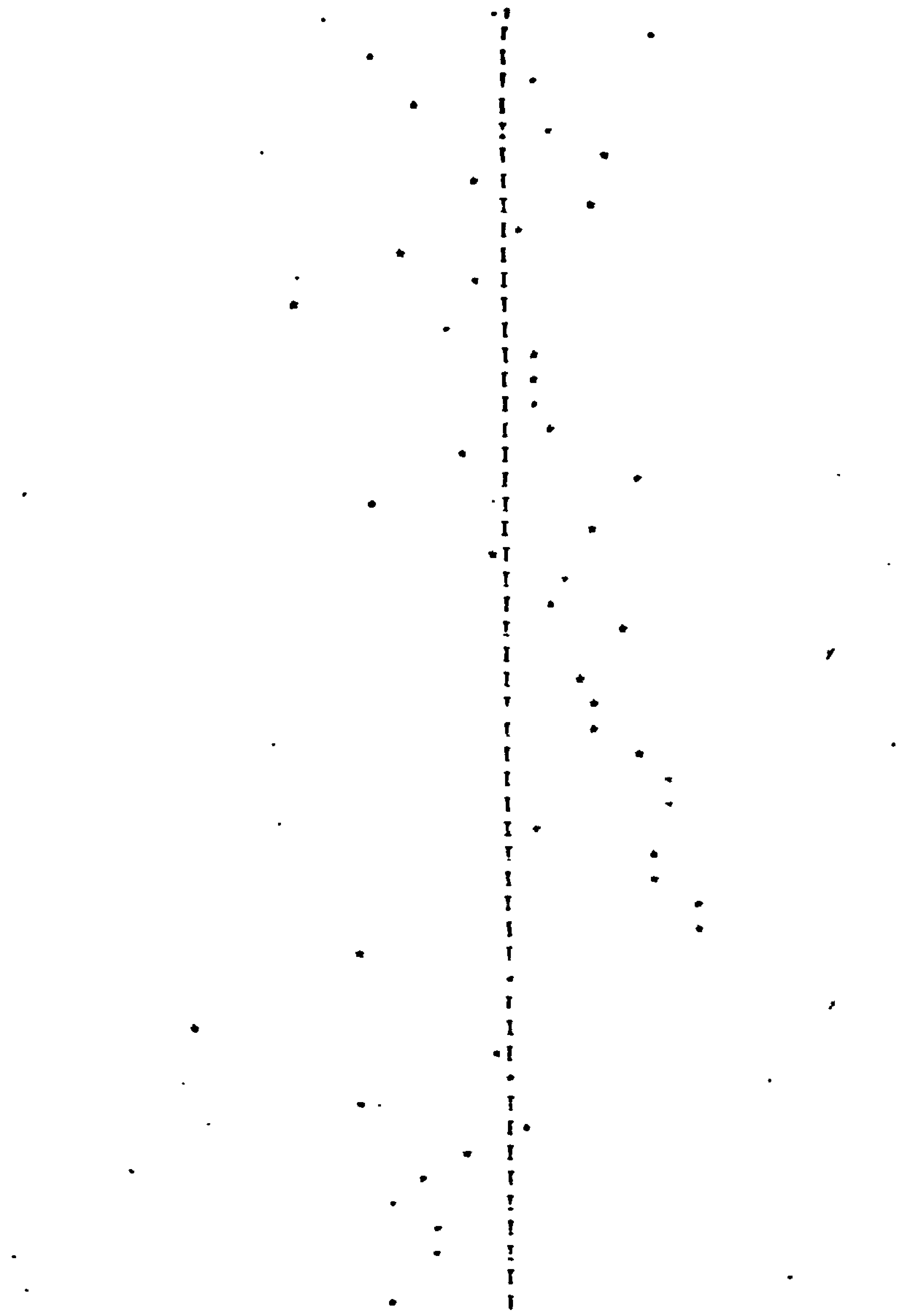
45	19.00000	19.07766	-0.7765825E-01
46	30.00000	19.89622	10.10378
47	35.00000	13.36615	21.63385
48	0.0000000	10.77955	-10.77955
49	17.00000	18.26369	-1.263691
50	0.0000000	8.892942	-8.892944
51	0.0000000	16.40391	-16.40391
52	0.0000000	13.16399	-13.16399
53	15.00000	15.07389	-0.7389326E-01
54	16.00000	15.61958	0.3804207
55	17.00000	9.298840	7.701159
56	0.0000000	15.99946	-15.99947
57	45.00000	22.24868	22.75131
58	0.0000000	21.51336	-21.51336
59	15.00000	12.80054	2.199461
60	25.00000	16.01026	8.989735
61	43.00000	19.22310	23.77690
62	0.0000000	20.01223	-20.01223
63	28.00000	16.28904	11.71096
64	0.0000000	12.80054	-12.80054
65	20.00000	32.64662	-12.64663
66	16.00000	27.27803	-11.27803
67	35.00000	24.63697	10.36303
68	20.00000	24.63394	-4.633941
69	15.00000	29.26998	-14.26999
70	18.00000	25.35101	-7.351018
71	0.0000000	29.26644	-29.26645
72	20.00000	25.72078	-5.720782
73	40.00000	24.06873	15.93127
74	20.00000	23.25019	-3.250199
75	49.00000	23.04387	25.95612
76	50.00000	33.59435	16.40564
77	20.00000	9.580456	10.41954
78	35.00000	19.02260	15.97740
79	19.00000	17.04382	1.956183
80	0.0000000	12.80054	-12.80054
81	15.25000	26.88456	-11.63459
82	21.00000	17.57641	3.423589
83	0.0000000	22.93127	-22.93128
84	30.00000	28.29462	1.705374
85	0.0000000	23.54372	-23.54373
86	12.50000	28.88934	-16.38984
87	19.00000	28.86984	-9.869839
88	19.00000	24.41796	-5.417961
89	17.50000	19.49790	-1.997904
90	35.00000	9.910744	25.08925
91	21.45000	18.38237	3.067625
92	15.60000	12.62805	2.971945
93	0.0000000	21.13496	-21.13496
94	25.80000	22.41037	3.389603
95	10.00000	22.93877	-12.93878
96	28.00000	17.00708	10.99292
97	12.37000	22.84452	-10.47452



I-16 (Contd.)

Plot of standardised residuals and table of observed and predicted values for total data matrix

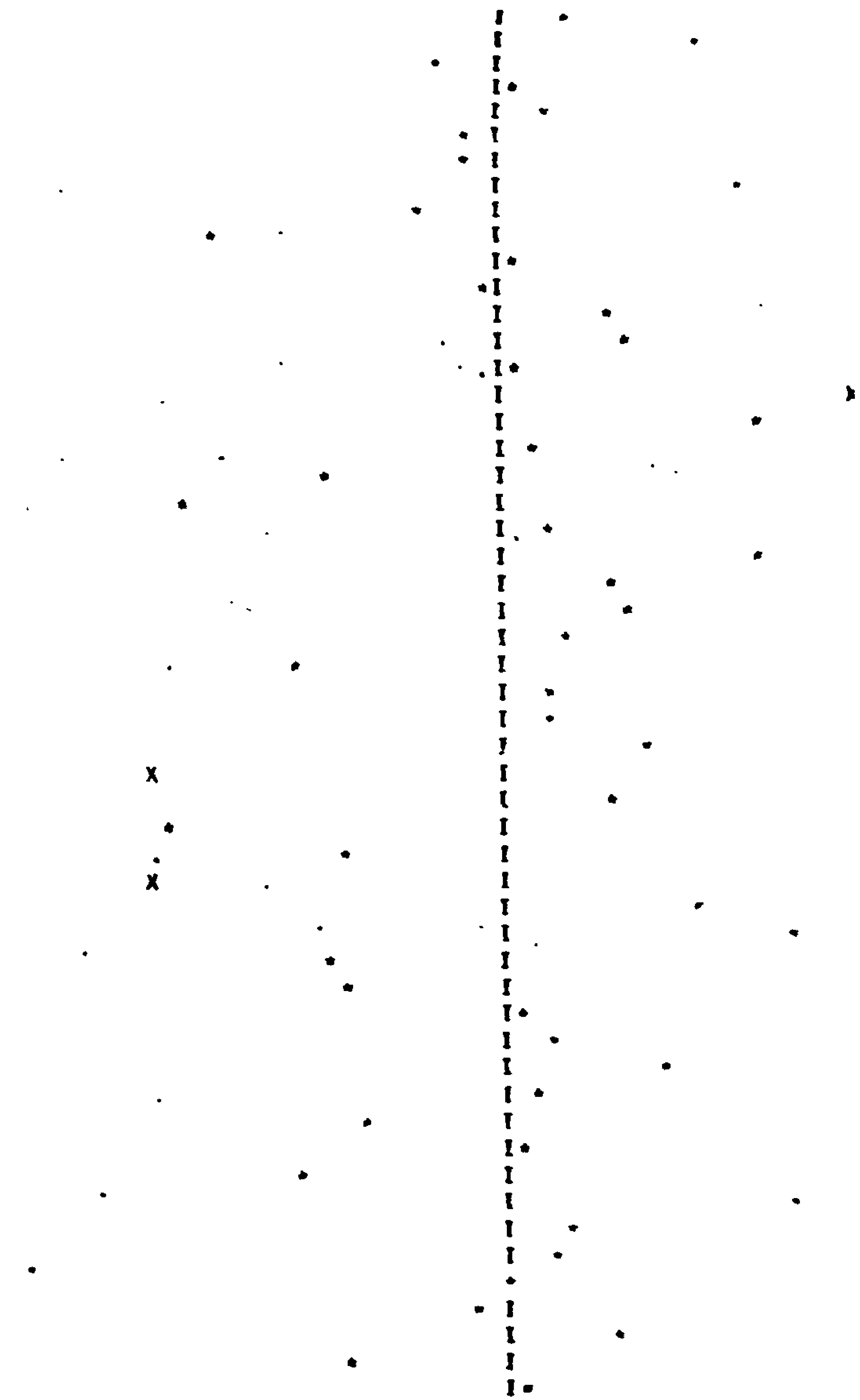
98	18.00000	19.94497	-1.944973
99	35.00000	21.36335	13.63665
100	0.0000000	12.86054	-12.86054
101	30.00000	27.71398	2.296017
102	0.0000000	8.718029	-8.718033
103	11.00000	6.736984	4.263013
104	23.00000	13.43538	9.564615
105	8.000000	11.05239	-3.052393
106	20.00000	11.58923	8.410769
107	10.00000	9.105453	0.8945452
108	0.0000000	10.09400	-10.09400
109	7.299999	10.60068	-3.300686
110	0.0000000	19.28918	-19.28919
111	7.299999	13.24479	-5.944798
112	15.00000	12.80054	2.199461
113	20.00000	17.66432	2.335680
114	15.00000	12.80054	2.199461
115	12.00000	8.123466	3.876532
116	25.00000	29.41585	-4.415851
117	30.00000	17.41618	12.58381
118	2.820000	15.44465	-12.62465
119	30.00000	22.40026	7.599736
120	15.00000	16.04647	-1.046473
121	25.00000	20.17218	4.827821
122	16.00000	12.59395	3.406046
123	32.00000	21.30256	10.69743
124	57.00000	26.91056	30.08944
125	27.00000	20.34985	6.650143
126	27.00000	18.48634	8.513655
127	30.00000	21.55109	8.448908
128	30.00000	18.16328	11.83671
129	35.00000	19.37350	15.62649
130	42.00000	27.28145	14.71855
131	28.36000	25.46004	2.899957
132	35.00000	21.87127	13.12873
133	35.00000	21.76398	13.23602
134	40.00000	21.77266	18.22734
135	30.00000	12.80054	17.19946
136	0.0000000	13.95675	-13.95675 X
137	27.00000	27.58574	-0.5857379
138	61.50000	31.08969	30.41031
139	0.0000000	26.98449	-26.98450
140	16.00000	17.39751	-1.397518
141	15.00000	15.60345	-0.6034514
142	0.0000000	13.70243	-13.70244 X
143	20.00000	19.22901	0.7719865
144	15.00000	18.55674	-3.556747
145	12.50000	21.16338	-8.663385
146	0.0000000	10.60069	-10.60069
147	20.00000	26.83377	-6.833769
148	20.00000	26.82965	-6.829658
149	54.00000	27.65316	26.34684
150	10.00000	21.05359	-11.05360



I-16 (Contd.)

Plot of standardised residuals and table of observed and predicted values for total data matrix

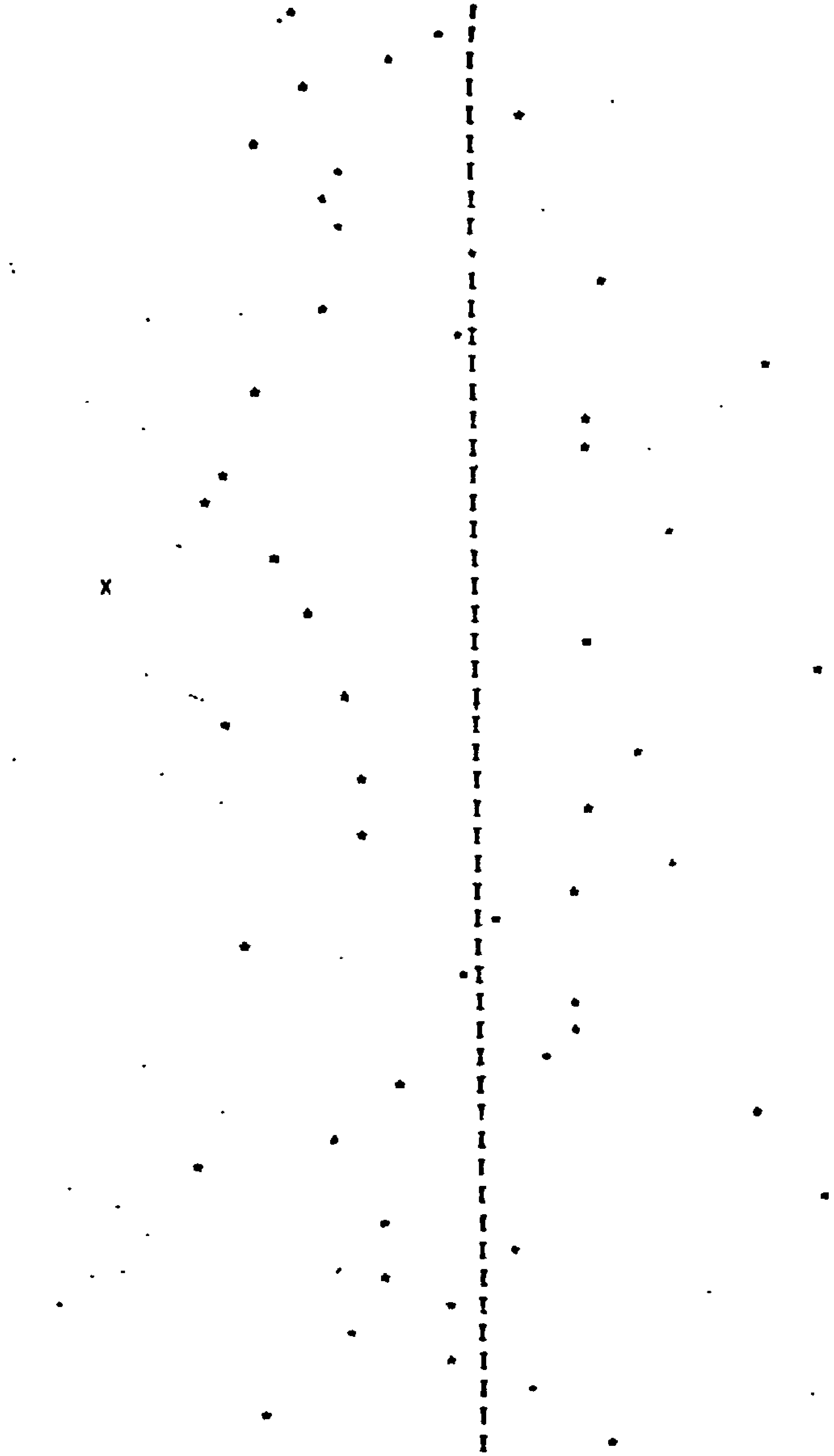
151	25.00000	19.95731	5.042693	
152	41.00000	24.88755	16.11244	
153	10.00000	15.12304	-5.123043	
154	28.00000	26.63571	1.364288	
155	26.50000	23.07176	3.428240	
156	17.00000	19.22801	-2.228014	
157	15.00000	17.32290	-2.322896	
158	48.00000	27.15363	20.84637	
159	12.00000	18.61990	-6.619903	
160	0.0000000	23.83954	-23.83954	
161	15.40000	13.43097	1.969033	
162	20.00000	21.42631	-1.426313	
163	35.00000	25.85178	9.148216	
164	40.00000	29.47675	10.52324	
165	18.00000	16.65596	1.344042	
166	85.00000	32.02027	52.97972	
167	50.00000	28.87925	21.12075	
168	30.00000	27.75048	2.249516	
169	5.400000	20.83107	-15.43108	
170	0.0000000	27.11210	-27.11210	
171	18.00000	13.43538	4.564616	
172	37.00000	15.44465	21.55535	
173	24.00000	14.01184	9.988153	
174	30.00000	19.24908	10.75092	
175	32.00000	26.68096	5.319039	
176	0.0000000	18.05141	-18.05141	
177	17.00000	13.24479	3.755203	
178	20.00000	16.05098	3.949022	
179	30.00000	18.29844	11.70156	
180	0.0000000	34.94859	-34.94859	X
181	21.00000	11.17106	9.828936	
182	0.0000000	28.72799	-28.72799	
183	0.0000000	13.87964	-13.87964	
184	0.0000000	30.37040	-30.37040	X
185	40.00000	23.06095	16.93904	
186	45.00000	20.72198	24.27802	
187	0.0000000	15.56600	-15.56601	
188	0.0000000	14.23725	-14.23726	
189	18.00000	16.28904	1.710963	
190	12.50000	8.024179	4.475820	
191	28.00000	14.43688	13.56312	
192	25.00000	22.32677	2.673227	
193	0.0000000	12.70656	-12.70656	
194	12.50000	11.30531	1.194692	
195	0.0000000	18.06503	-18.06504	
196	46.00000	21.49425	24.50575	
197	30.00000	24.71098	5.289020	
198	35.00000	30.51100	4.488997	
199	25.00000	25.27366	-0.2736654	
200	25.00000	27.23694	-2.236941	
201	35.00000	26.14269	8.857304	
202	0.0000000	13.36615	-13.36615	
203	27.00000	25.43324	1.566759	



I-16 (Contd.)

Plot of standardised residuals and table of observed and predicted values for total data matrix

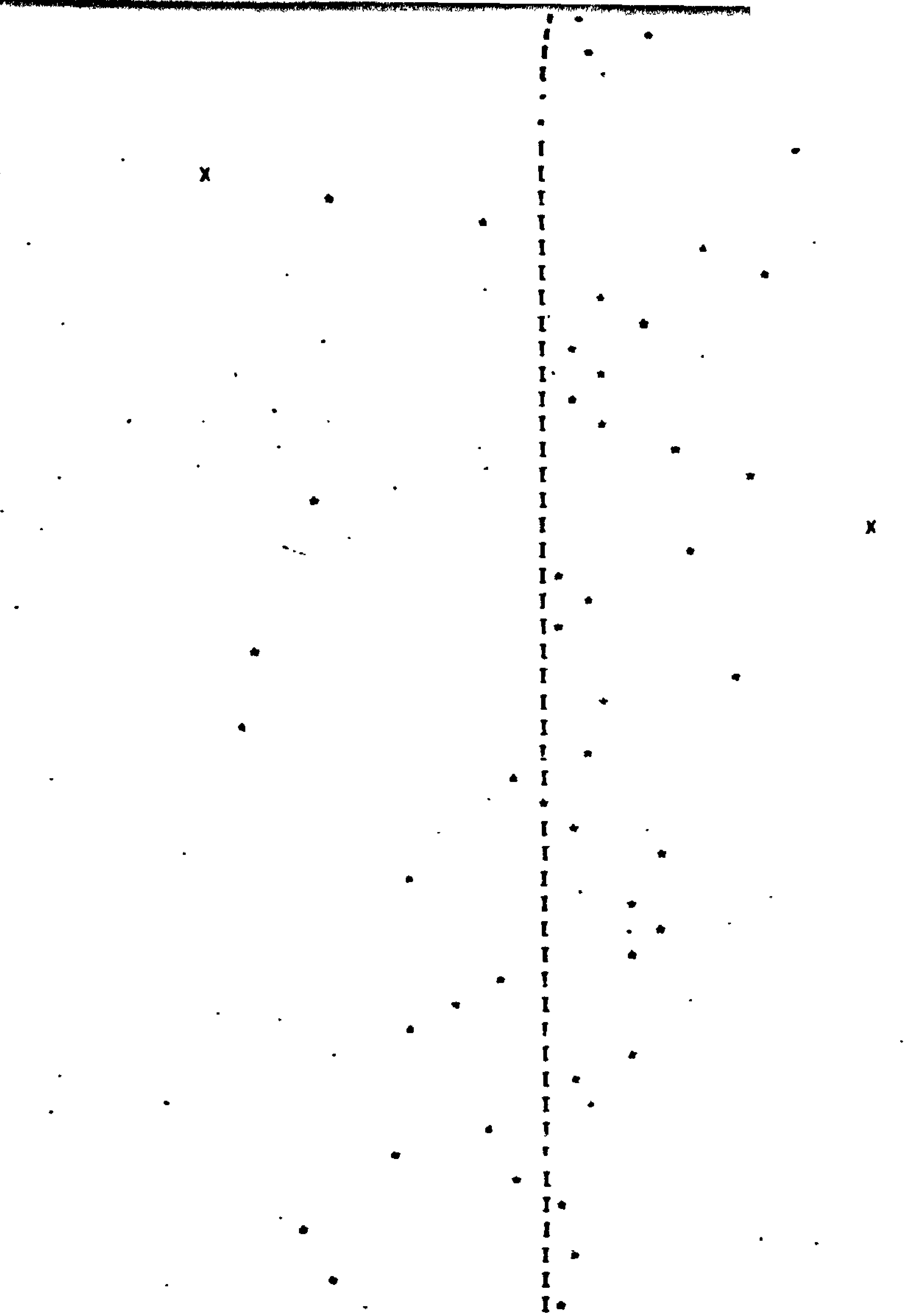
204	0.0000000	15.99965	-15.99965
205	30.00000	32.43719	-2.437200
206	18.00000	25.21741	-7.217412
207	0.0000000	14.01184	-14.01185
208	37.00000	32.26476	4.735239
209	0.0000000	17.49302	-17.49302
210	0.0000000	10.60068	-10.60069
211	14.30000	25.88874	-11.58875
212	15.00000	25.44588	-10.44589
213	20.00000	20.62871	-0.6287092
214	41.00000	29.95288	11.04712
215	14.00000	26.87122	-12.87123
216	14.00000	15.44465	-1.444650
217	50.00000	25.82840	24.17160
218	0.0000000	18.19705	-18.19706
219	30.00000	20.78644	9.213560
220	30.00000	20.27877	9.721222
221	0.0000000	20.17594	-20.17595
222	0.0000000	21.42904	-21.42904
223	25.00000	9.001953	15.99804
224	9.000000	25.79714	-16.79714
225	0.0000000	33.04042	-33.04043
226	0.0000000	14.22857	-14.22856
227	50.00000	40.34300	9.656992
228	55.00000	26.16475	28.83525
229	0.0000000	11.15168	-11.15168
230	0.0000000	20.69012	-20.69012
231	32.00000	18.13799	13.86201
232	0.0000000	9.105453	-9.105455
233	25.00000	16.02946	8.970531
234	0.0000000	9.165785	-9.165787
235	33.00000	17.16042	15.83956
236	30.00000	21.30638	8.693621
237	25.00000	23.15116	1.848836
238	0.0000000	18.51605	-18.51605
239	11.50000	12.80054	-1.300538
240	22.00000	14.01184	7.988153
241	35.00000	27.51152	7.488675
242	30.00000	24.94714	5.052857
243	6.099999	12.80054	-6.700540
244	60.00000	36.88315	23.11684
245	3.000000	15.70501	-12.70502
246	4.500000	27.79223	-23.29223
247	70.00000	41.05280	28.94719
248	29.00000	36.49291	-7.492919
249	20.00000	17.20024	2.799755
250	20.00000	27.85493	-7.854929
251	24.00000	27.27803	-3.278028
252	16.00000	26.43443	-10.43443
253	18.00000	20.36909	-2.369087
254	36.00000	32.57656	3.423432
255	0.0000000	16.34912	-16.34913
256	42.00000	30.54400	11.45599



I-16 (Contd.)

Plot of standardised residuals and table of observed and predicted values for total data matrix

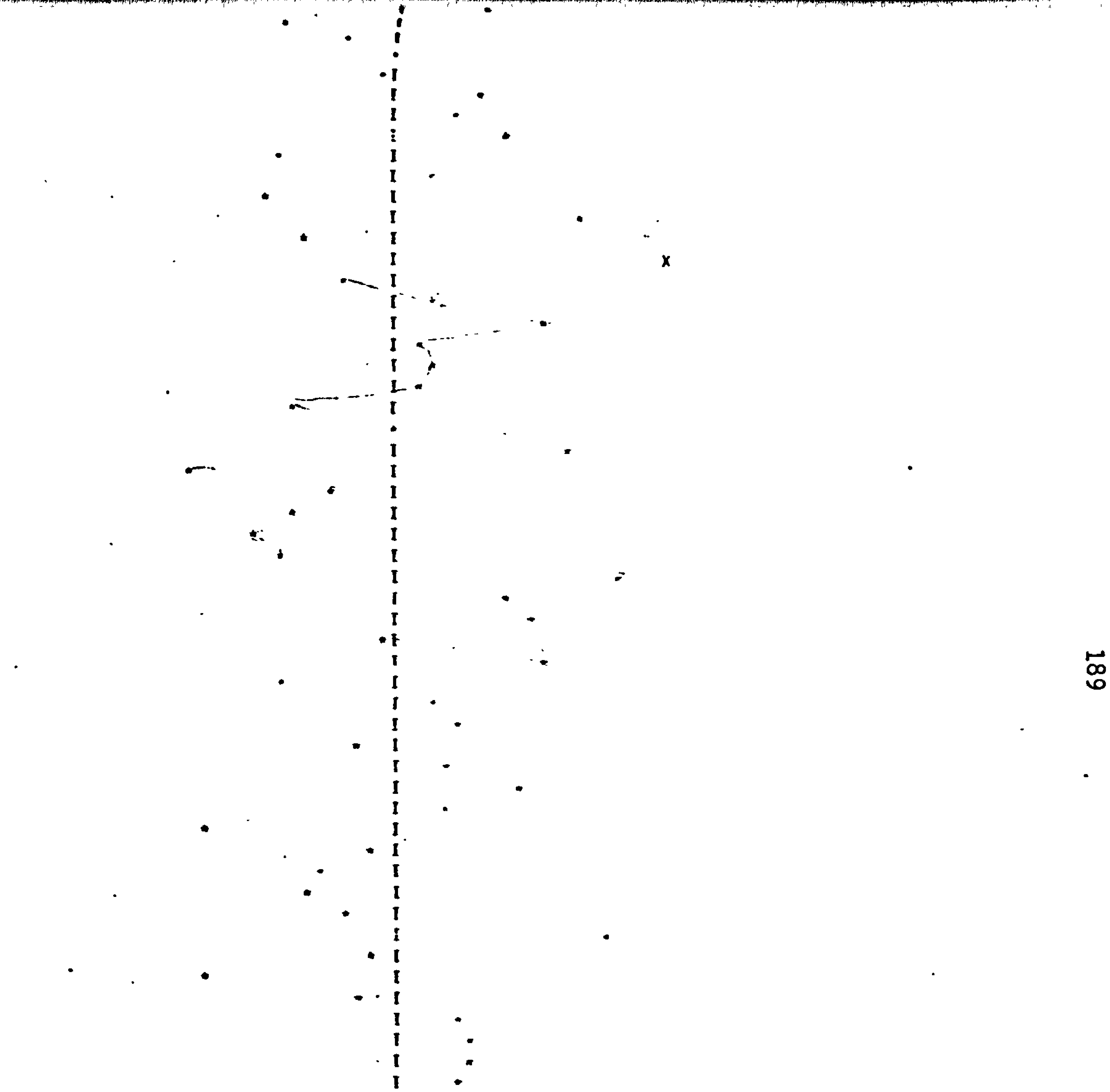
257	27.00000	[illegible]	[illegible]
258	33.50000	24.43763	9.062366
259	18.00000	13.94942	4.050579
260	20.00000	13.90315	6.096849
261	24.00000	24.27330	-0.2733048
262	27.00000	26.88916	0.1108390
263	40.00000	16.28310	23.71689
264	0.0000000	31.04698	-31.04698
265	0.0000000	18.65053	-18.65053
266	20.00000	26.04442	-6.044426
267	46.00000	31.39740	14.60260
268	39.00000	18.71001	20.28999
269	34.00000	28.87362	5.126375
270	41.00000	31.86803	9.131969
271	24.00000	21.03793	2.962068
272	32.00000	26.99617	5.003823
273	25.50000	23.11276	2.387239
274	35.00000	29.47788	5.522119
275	35.00000	23.30562	11.65437
276	39.00000	19.66902	19.33098
277	0.0000000	19.85270	-19.85270
278	63.07999	32.86507	30.21492
279	41.00000	27.11071	13.88929
280	30.00000	28.78794	1.212059
281	32.00000	27.53627	4.463725
282	22.00000	21.17068	0.8293194
283	0.0000000	25.78086	-25.78086
284	37.00000	19.32592	17.67407
285	25.00000	19.54669	5.453308
286	0.0000000	27.36001	-27.36001
287	28.00000	23.77430	4.225699
288	20.00000	23.26162	-3.261619
289	15.20000	15.45575	-0.2557514
290	15.00000	12.80054	2.199461
291	30.00000	18.91803	11.08196
292	0.0000000	11.81199	-11.81199
293	25.00000	16.37819	8.621803
294	25.00000	13.91184	11.08816
295	15.00000	7.506723	7.493275
296	17.00000	20.91569	-3.915693
297	10.15000	17.80747	-7.657473
298	10.00000	22.74177	-12.74177
299	25.00000	16.28904	8.710962
300	25.00000	22.39431	2.605687
301	16.50000	12.80054	3.699461
302	30.00000	35.95033	-5.950330
303	7.000000	21.22697	-14.22697
304	19.50000	22.73079	-3.230796
305	20.00000	19.02853	0.9714646
306	9.500000	31.04724	-21.54724
307	18.20000	15.00039	3.199605
308	0.0000000	19.02151	-19.02151
309	18.00000	17.02724	0.9727613



I-16 (Contd.)

Plot of standardised residuals and table of observed and predicted values for total data matrix

311	[illegible]	[illegible]	[illegible]
312	22.00000	[illegible]	[illegible]
313	25.00000	25.33385	-0.3336540
314	32.82000	33.90303	-1.073043
315	30.00000	19.84436	10.15564
316	40.00000	33.02365	6.976352
317	40.00000	27.12838	12.87162
318	20.00000	31.64257	-11.64258
319	38.00000	34.50357	3.496422
320	20.00000	34.08648	-14.08648
321	37.50000	17.29080	20.20919
322	12.00000	20.83709	-8.837095
323	65.50000	31.61678	33.88322
324	16.70000	21.88837	-5.188379
325	23.50000	19.09212	4.407880
326	31.80000	15.00039	16.79961
327	20.00000	16.67342	3.326583
328	20.00000	16.14927	3.850727
329	25.00000	22.11771	2.882288
330	0.0000000	11.30531	-11.30531
331	15.00000	15.44465	-0.4446503
332	44.56000	25.67682	18.88318
333	0.0000000	21.63694	-21.63694
334	21.00000	27.44774	-6.447746
335	4.000000	15.44465	-11.44465
336	25.00000	40.12186	-15.12186
337	23.00000	35.25890	-12.25891
338	40.00000	16.14927	23.85072
339	28.50000	16.35512	12.14488
340	34.50000	19.20693	15.29307
341	27.00000	27.98053	-0.9805331
342	37.00000	21.35279	15.64721
343	7.500000	20.39976	-12.89976
344	20.00000	16.52147	3.478524
345	18.00000	10.60068	7.399315
346	12.00000	16.75531	-4.755318
347	25.00000	19.58991	5.410084
348	37.50000	23.69545	13.80455
349	18.00000	12.86054	5.139461
350	0.0000000	20.78999	-20.78999
351	20.00000	22.22929	-2.229287
352	10.00000	13.19156	-3.191559
353	11.50000	20.85267	-9.352671
354	10.00000	15.44465	-5.444651
355	40.50000	17.35610	23.14390
356	23.00000	25.70608	-2.706085
357	0.0000000	20.59976	-20.59977
358	23.00000	26.83377	-3.833769
359	22.00000	15.44465	6.555349
360	27.00000	18.62823	8.371769
361	27.00000	19.13973	7.860266
362	20.00000	12.80054	7.199461



I-16 (Contd.)

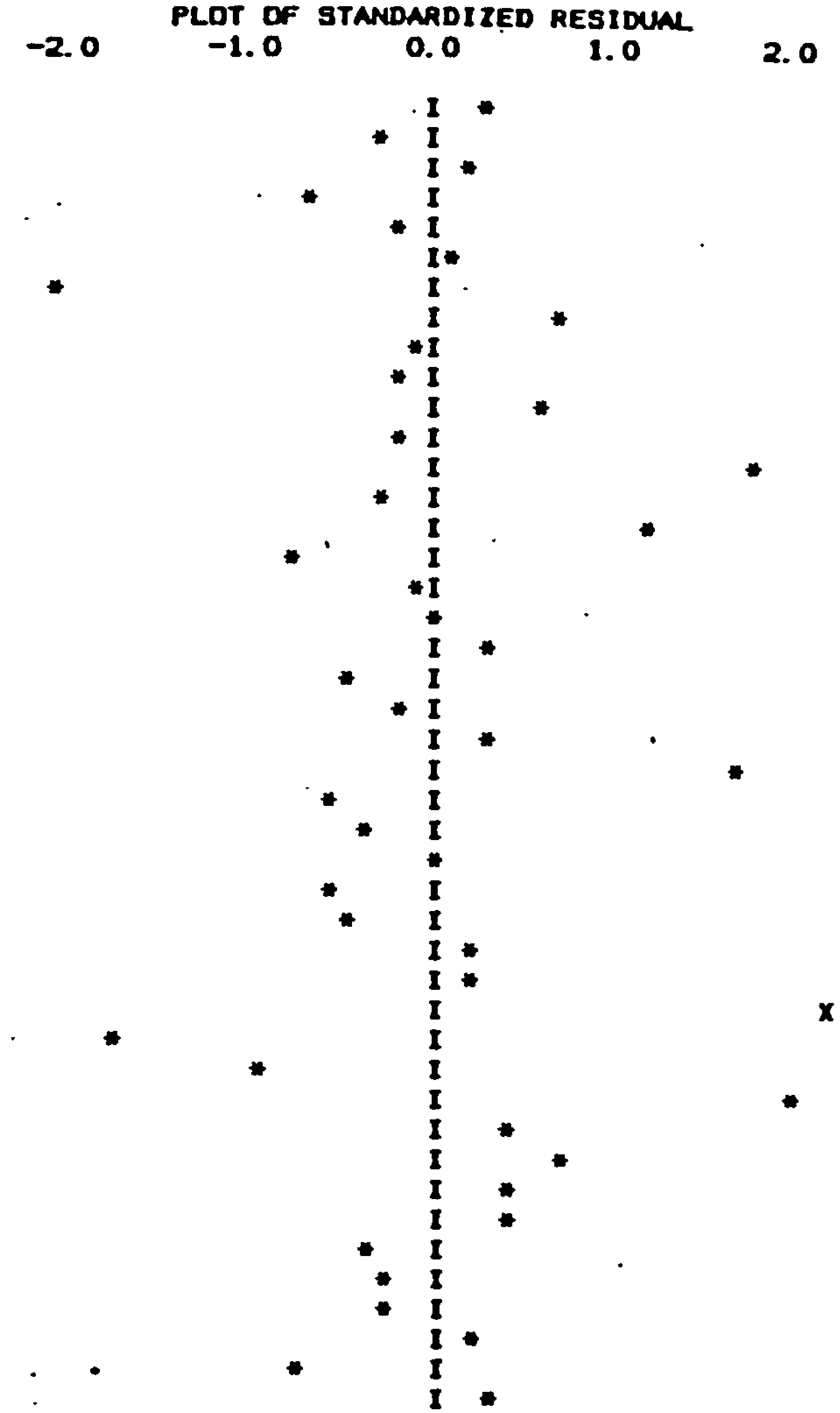
Plot of standardised residuals and table of observed and predicted values for total data matrix

APPENDIX J

MULTIPLE REGRESSION

DEPENDENT VARIABLE: E FROM VARIABLE LIST 1
REGRESSION LIST 1

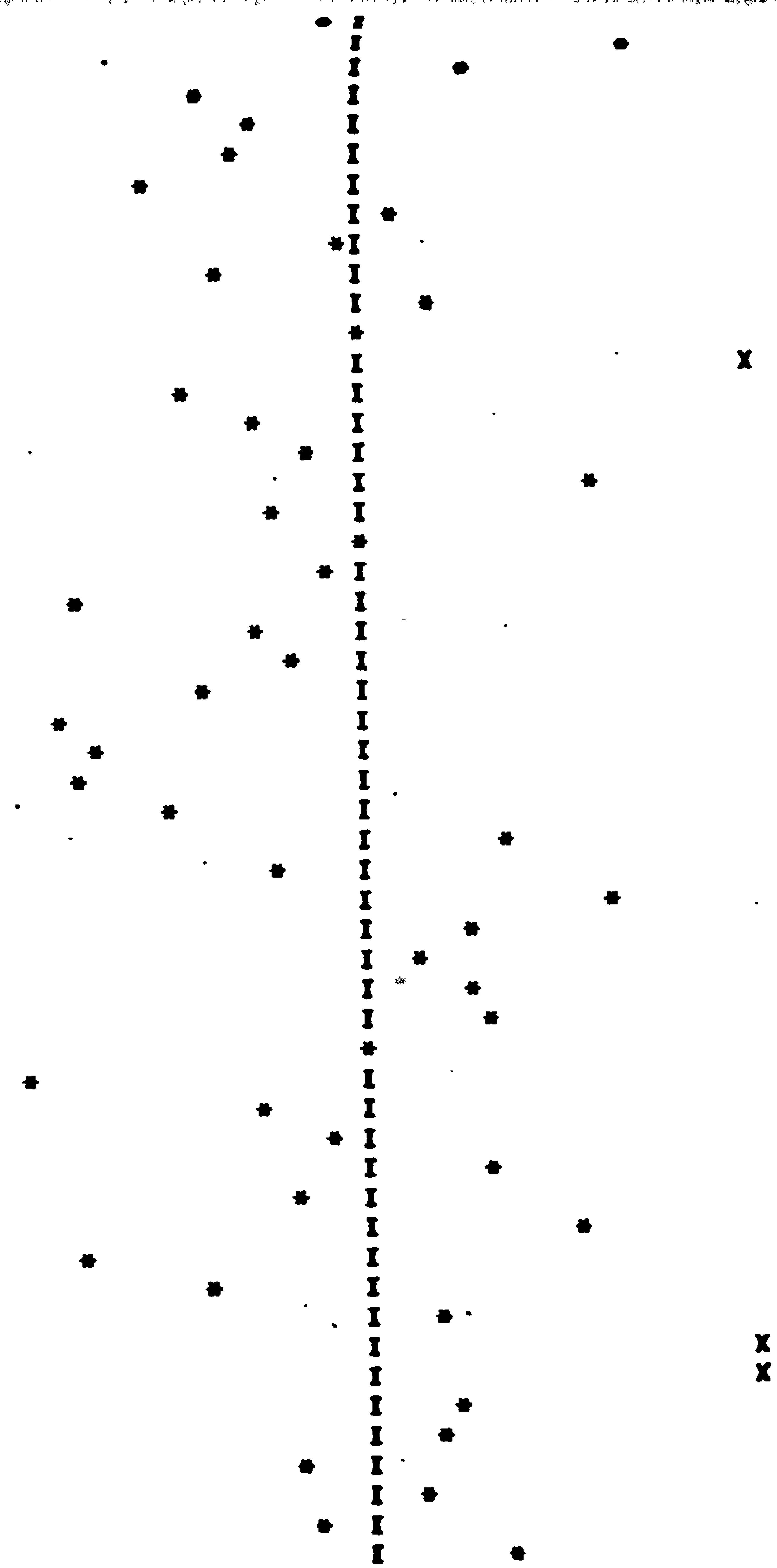
SEQNUM	OBSERVED E	PREDICTED E	RESIDUAL
1	35.00000	30.98057	4.019424
2	23.00000	26.58274	-3.582748
3	40.00000	37.32748	2.672522
4	23.50000	31.97405	-8.474052
5	33.00000	35.86749	-2.867496
6	34.00000	32.81111	1.188885
7	17.00000	43.60252	-26.60252
8	40.00000	31.72375	8.276251
9	21.00000	21.74156	-0.7415631
10	25.00000	27.73963	-2.739635
11	35.00000	27.10867	7.891327
12	35.00000	37.50578	-2.505782
13	52.50000	30.57887	21.92113
14	22.00000	26.18138	-4.181386
15	40.00000	25.38540	14.61460
16	25.00000	34.89169	-9.891689
17	20.00000	20.64711	-0.6471106
18	38.00000	38.15061	-0.1506144
19	30.00000	25.86871	4.131288
20	20.00000	25.74052	-5.740523
21	20.00000	22.17338	-2.173380
22	30.00000	26.30848	3.691519
23	51.25000	30.09480	21.15519
24	15.20000	23.04744	-7.847442
25	12.50000	17.87560	-5.375599
26	34.00000	33.41081	0.5891855
27	16.70000	23.87803	-7.178031
28	12.50000	18.62472	-6.124724
29	21.50000	18.58418	2.915818
30	25.00000	23.04744	1.952559
31	80.00000	32.87164	47.12836
32	15.00000	37.88017	-22.88017
33	26.00000	38.88202	-12.88203
34	55.00000	30.40691	24.59309
35	23.50000	18.59992	4.900080
36	42.00000	33.02119	8.978800
37	40.00000	34.91358	5.086412
38	22.00000	16.81574	5.184258
39	11.00000	16.10348	-5.103486
40	15.00000	18.13449	-3.134495
41	37.50000	41.15385	-3.653850
42	31.00000	27.97024	3.029754
43	12.00000	22.42152	-10.42152
44	28.00000	23.86315	4.136846



J-1

Plot of standardised residuals and table of observed and predicted values for total data matrix with respect to the variable E

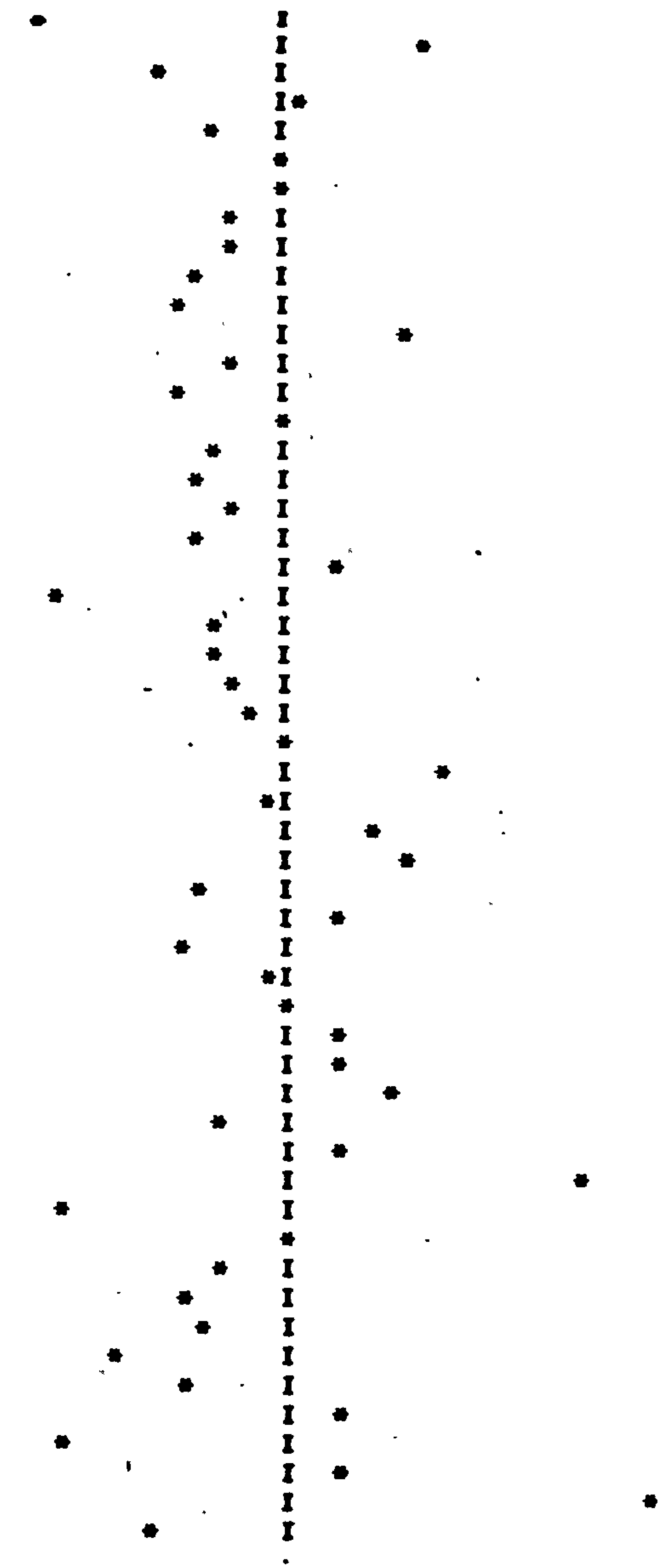
45	18.00000	20.38175	-2.381755
46	57.00000	38.37046	18.62953
47	35.00000	27.78823	7.211765
48	8.000000	19.56689	-11.56689
49	17.00000	24.17843	-7.178430
50	15.20000	23.60098	-8.400980
51	17.00000	32.17705	-15.17706
52	27.00000	25.05569	1.944305
53	24.00000	25.82198	-1.821985
54	16.00000	26.04092	-10.04093
55	27.50000	23.05223	4.447764
56	33.00000	32.90235	0.9764732E-01
57	77.00000	48.72742	28.27258
58	29.00000	40.81026	-11.81027
59	15.00000	23.04744	-8.047441
60	25.00000	28.53736	-3.537360
61	43.00000	27.30396	15.69604
62	28.00000	33.95358	-5.953588
63	28.00000	28.52003	-0.5200318
64	21.00000	23.04744	-2.047441
65	28.00000	48.46862	-20.46863
66	31.50000	38.53137	-7.031374
67	35.00000	40.36002	-5.360032
68	20.00000	31.47104	-11.47104
69	15.00000	36.66613	-21.66614
70	18.00000	36.70580	-18.70581
71	21.00000	40.93100	-19.93101
72	20.00000	33.34789	-13.34789
73	40.00000	29.96908	10.03092
74	26.00000	32.25229	-6.252292
75	49.00000	31.47578	17.52422
76	50.00000	43.02016	6.979837
77	20.00000	16.17095	3.829049
78	35.00000	27.16400	7.836000
79	34.50000	26.42687	8.073128
80	23.00000	23.04744	-0.4744048E-01
81	17.75000	41.17846	-23.42846
82	26.00000	32.94050	-6.940501
83	28.00000	30.77292	-2.772920
84	45.00000	36.68486	8.315132
85	25.00000	29.73869	-4.738692
86	53.50000	38.53137	14.96863
87	19.00000	38.53137	-19.53138
88	39.00000	49.67773	-10.67774
89	39.89999	35.35698	4.543011
90	51.89999	21.47519	30.42480
91	69.70000	22.31501	47.38498
92	29.60000	22.87697	6.723022
93	40.70000	36.01380	4.686194
94	25.80000	30.20901	-4.409011
95	40.07000	36.66438	3.405612
96	28.00000	32.23058	-4.230587
97	46.00000	36.10569	9.894306



J-1 (Contd.)

Plot of standardised residuals and table of observed and predicted values for total data matrix with respect to the variable E

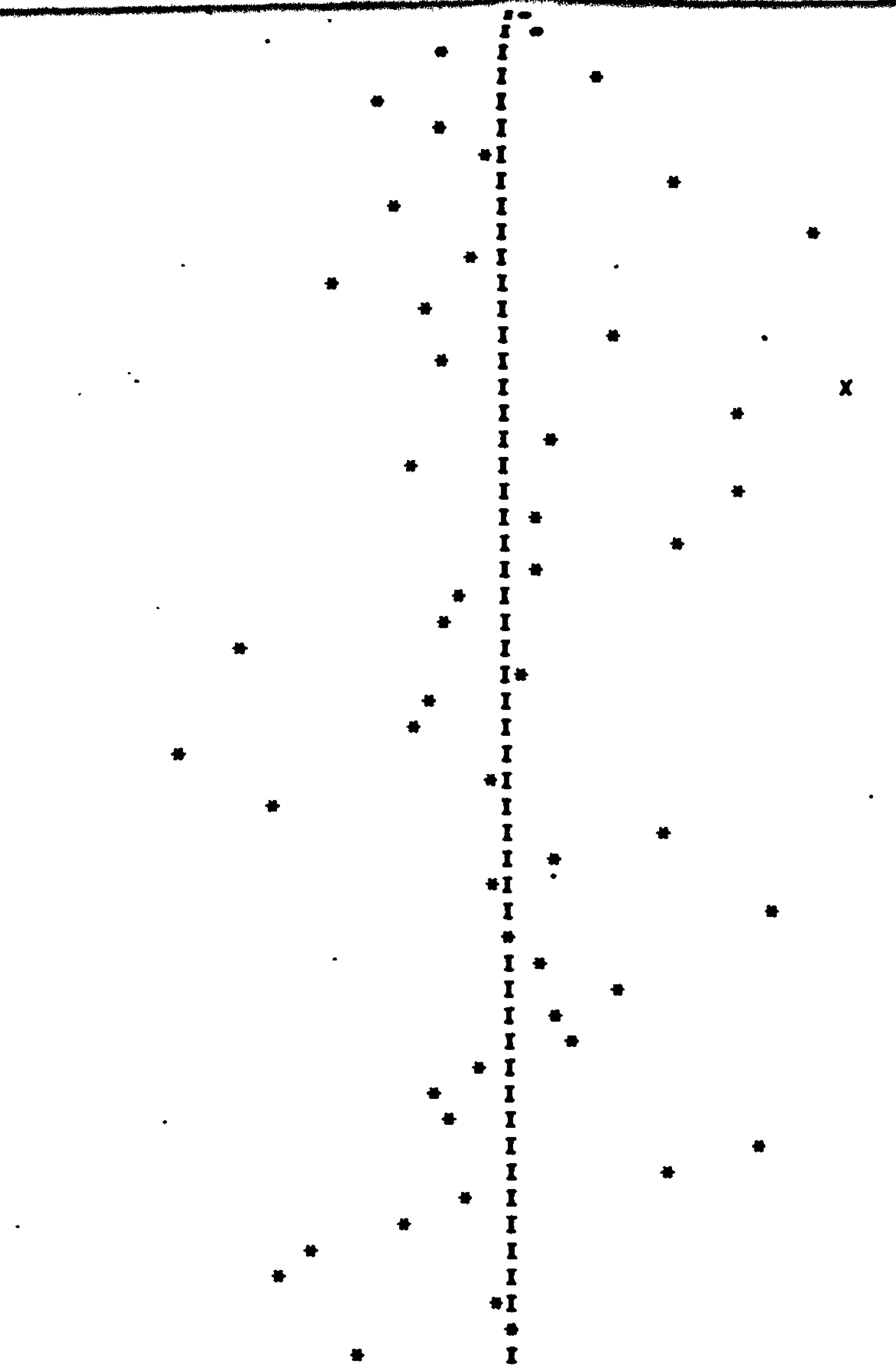
98	18.00000	34.86419	-16.86420
99	46.70000	36.42665	10.27334
100	14.00000	23.04744	-9.047441
101	41.00000	39.60421	1.395788
102	10.00000	15.31862	-5.318627
103	20.50000	20.36172	0.1382800
104	23.00000	23.12890	-0.1289023
105	16.00000	19.67636	-3.676362
106	20.00000	24.26186	-4.261860
107	10.00000	15.94056	-5.940562
108	12.00000	19.09002	-7.090017
109	29.30000	21.11240	8.187595
110	26.50000	30.65714	-4.157139
111	14.80000	21.86153	-7.061530
112	23.00000	23.04744	-0.4744048E-01
113	26.00000	30.63676	-4.636758
114	17.00000	23.04744	-6.047441
115	12.00000	15.51760	-3.517599
116	37.00000	43.08251	-6.082520
117	30.00000	26.28704	3.712952
118	8.099998	23.79656	-15.69657
119	30.00000	34.67998	-4.679984
120	15.00000	20.45016	-5.450164
121	33.00000	36.52828	-3.528284
122	16.00000	18.54037	-2.540370
123	32.00000	32.53497	-0.5349706
124	57.00000	45.86213	11.13787
125	38.00000	38.83511	-0.8351204
126	37.00000	30.39244	6.607556
127	41.00000	31.83503	9.164967
128	30.00000	36.53436	-6.534368
129	35.00000	31.52504	3.474962
130	45.00000	52.00856	-7.008570
131	49.63000	50.88451	-1.254516
132	35.00000	34.56899	0.4310051
133	35.00000	31.27400	3.725997
134	40.00000	36.04871	3.951285
135	30.00000	23.04744	6.952559
136	17.00000	21.75494	-4.754950
137	47.00000	43.07813	3.921871
138	61.50000	40.46641	21.03359
139	30.00000	46.72720	-16.72720
140	27.00000	26.88324	0.1167564
141	13.00000	17.83379	-4.833787
142	12.00000	19.77636	-7.776365
143	20.00000	26.72727	-6.727273
144	15.00000	26.94833	-11.94834
145	22.50000	29.41028	-6.910282
146	25.00000	21.11240	3.887596
147	24.00000	40.23960	-16.23961
148	35.00000	30.85900	4.141002
149	58.50000	32.43077	26.06923
150	17.00000	27.14798	-10.14799



J-1 (Contd.)

Plot of standardised residuals and table of observed and predicted values for total data matrix with respect to the variable E

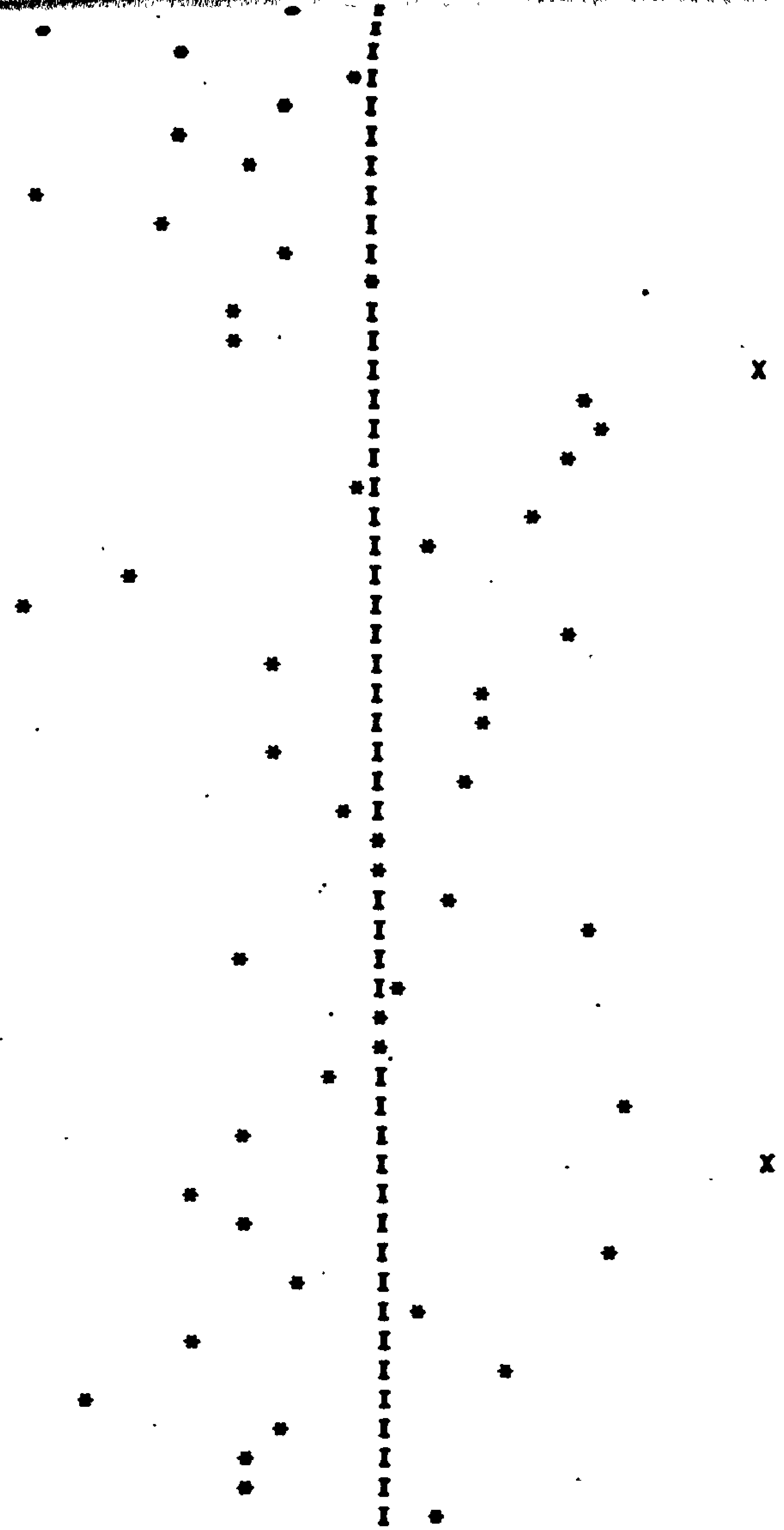
151	25.66666	[illegible]	1.844674
152	41.00000	38.26008	2.739915
153	10.00000	14.88070	-4.880705
154	41.00000	33.33080	7.669190
155	26.50000	35.88212	-9.382124
156	22.00000	26.72727	-4.727273
157	15.00000	16.81574	-1.815741
158	48.00000	34.43826	13.56173
159	12.00000	20.68841	-8.688416
160	60.00000	34.63929	25.36071
161	15.40000	17.66332	-2.263323
162	20.00000	33.32728	-13.32729
163	35.00000	40.60013	-5.600133
164	61.00000	52.48476	8.515236
165	18.00000	22.58215	-4.582148
166	85.50000	54.72702	30.77297
167	75.00000	56.11807	18.88192
168	45.50000	41.61964	3.880349
169	20.40000	27.83125	-7.431252
170	60.00000	41.18784	18.81216
171	26.00000	23.12890	2.871098
172	37.00000	23.79656	13.20343
173	24.00000	21.83302	2.166978
174	30.00000	33.24460	-3.244602
175	32.00000	37.31044	-5.310442
176	12.00000	33.17088	-21.17089
177	23.00000	21.86153	1.138471
178	20.00000	25.70206	-5.702066
179	30.00000	37.48213	-7.482140
180	35.00000	61.34837	-26.34837
181	21.00000	22.22362	-1.223624
182	33.00000	51.18960	-18.18961
183	34.50000	21.94299	12.55701
184	56.00000	52.81560	3.184396
185	40.00000	40.95070	-0.9507016
186	61.50000	40.81706	20.68293
187	30.00000	29.72327	0.2767289
188	26.00000	23.12563	2.874363
189	34.00000	25.38609	8.613913
190	21.00000	17.04444	3.955560
191	28.00000	23.12833	4.871669
192	30.00000	32.55222	-2.552219
193	15.00000	21.39246	-6.392459
194	12.50000	17.87560	-5.375599
195	55.00000	34.60378	20.39621
196	53.00000	40.95303	12.04696
197	30.00000	33.53909	-3.539100
198	35.00000	43.42091	-8.420918
199	25.00000	40.68514	-15.68515
200	25.00000	43.92382	-18.92383
201	42.00000	43.35817	-1.358172
202	25.00000	25.17661	-0.1766137
203	27.00000	39.78483	-12.78484



J-1 (Contd.)

Plot of standardised residuals and table of observed and predicted values for total data matrix with respect to the variable E

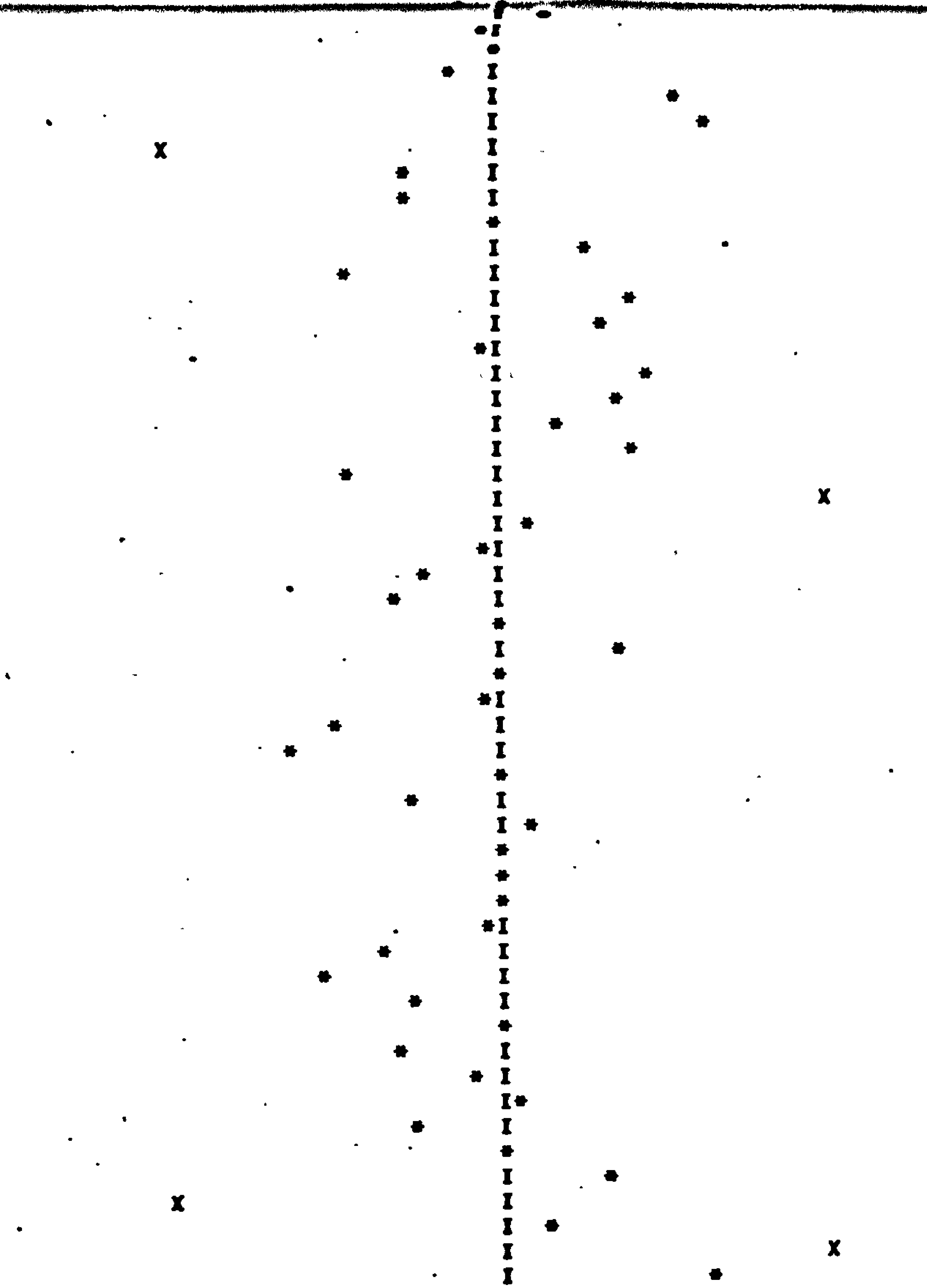
[illegible]	17.[illegible]	[illegible]	[illegible]
205	30.00000	54.12283	-24.12284
206	18.00000	31.31897	-13.31898
207	20.00000	21.83302	-1.833022
208	37.00000	43.22428	-6.224284
209	15.00000	28.93721	-13.93722
210	12.00000	21.11240	-9.112404
211	14.30000	37.76805	-23.46806
212	20.50000	34.83754	-14.33755
213	25.00000	31.61802	-6.618019
214	41.00000	40.69679	0.3032007
215	24.00000	33.99685	-9.996855
216	14.00000	23.79656	-9.796566
217	100.0000	49.32853	50.67146
218	51.00000	36.45424	14.54575
219	55.00000	38.30080	16.69920
220	47.50000	33.47954	14.02046
221	40.00000	40.72881	-0.7288086
222	51.00000	39.68121	11.31879
223	25.00000	21.70488	3.295113
224	25.00000	42.39474	-17.39475
225	30.00000	54.36745	-24.36746
226	41.00000	27.33475	13.66525
227	65.00000	72.69553	-7.695539
228	55.00000	47.33421	7.665781
229	26.30000	18.67184	7.628154
230	22.00000	29.86421	-7.864209
231	37.00000	30.24094	6.759063
232	14.00000	15.94056	-1.940562
233	25.00000	25.55737	-0.5573729
234	25.00000	24.49393	0.5060663
235	33.00000	28.52723	4.472769
236	50.00000	34.71841	15.28158
237	25.00000	34.77077	-9.770771
238	30.00000	28.17444	1.825556
239	23.50000	23.04744	0.4525595
240	22.00000	21.83302	0.1669781
241	35.00000	38.40135	-3.401358
242	63.00000	46.02434	16.97565
243	13.50000	23.04744	-9.547441
244	80.00000	47.66479	32.33520
245	8.000000	21.74567	-13.74567
246	26.00000	35.58434	-9.584351
247	70.00000	54.31316	15.68683
248	48.00000	54.55215	-6.552157
249	29.00000	26.91751	2.082486
250	24.00000	37.50858	-13.50858
251	47.00000	38.53137	8.468626
252	16.00000	36.68118	-20.68119
253	18.00000	25.76183	-7.761830
254	36.00000	45.97654	-9.976549
255	12.25000	22.49480	-10.24480
256	44.00000	40.24747	3.752530



J-1 (Contd.)

Plot of standardised residuals and table of observed and predicted values for total data matrix with respect to the variable E

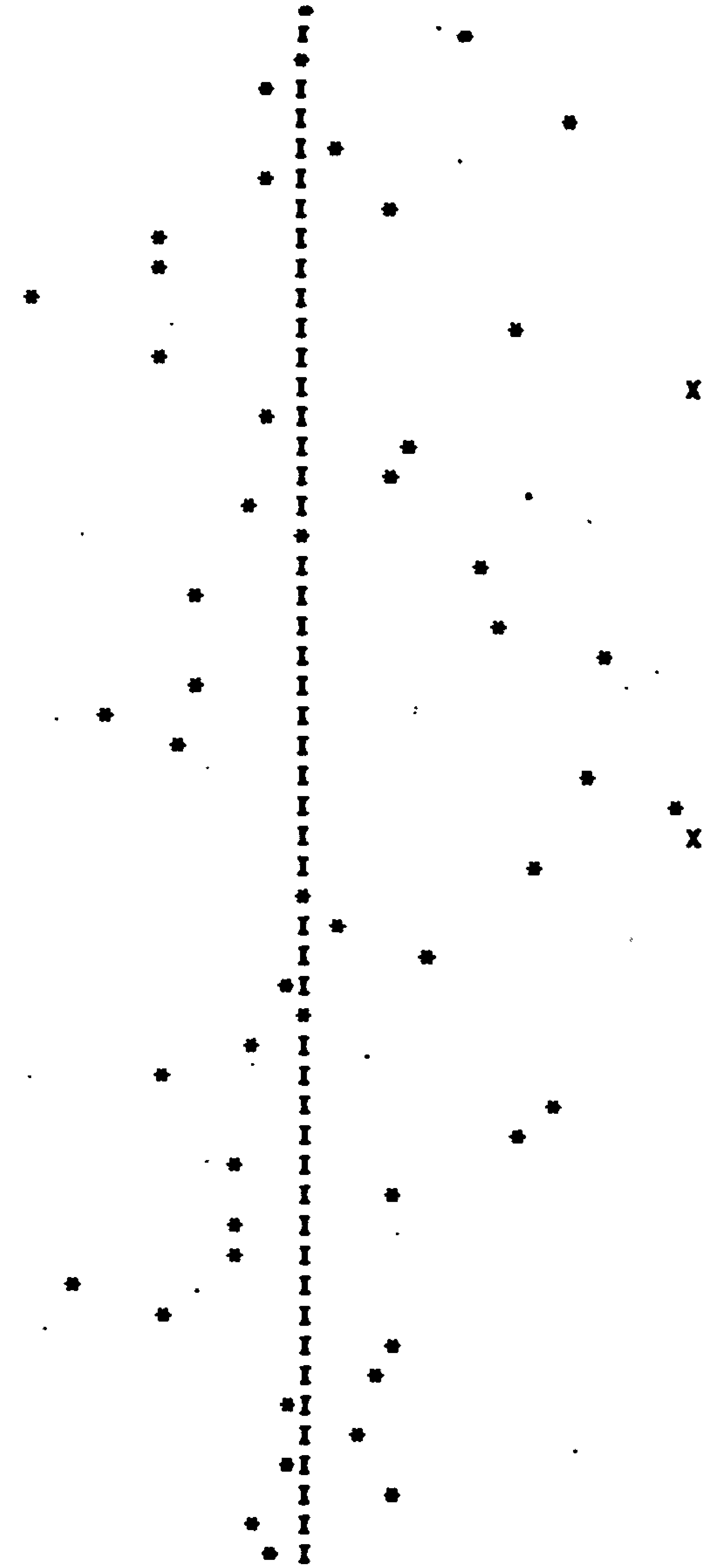
257	[illegible]	[illegible]	[illegible]
258	35.79999	32.19247	3.597519
259	18.00000	18.62472	-0.6247238
260	20.00000	20.17670	-0.1766994
261	27.00000	30.31374	-3.313747
262	51.60000	36.78726	14.81273
263	46.00000	28.64683	17.35317
264	15.00000	47.22744	-32.22745
265	25.74000	32.74203	-7.002036
266	20.00000	27.95711	-7.957112
267	46.00000	46.58013	-0.5801376
268	39.00000	31.20658	7.793411
269	34.00000	46.31483	-12.31484
270	64.98000	53.98536	10.99463
271	44.00000	35.47698	8.523014
272	32.00000	33.41772	-1.417719
273	46.00000	33.27495	12.72505
274	51.00000	40.46641	10.53359
275	35.00000	29.51711	5.482894
276	39.00000	27.40482	11.59518
277	20.00000	32.32736	-12.32737
278	92.23000	47.72065	44.50934
279	51.00000	48.11429	2.885705
280	40.00000	40.82919	-0.8291996
281	32.00000	38.41106	-6.411060
282	22.00000	30.18747	-8.187475
283	34.00000	34.29145	-0.2914574
284	37.00000	27.20400	9.795994
285	25.00000	24.67555	0.3244469
286	51.59000	52.96253	-1.372540
287	28.00000	41.80164	-13.80164
288	20.00000	37.55734	-17.55735
289	24.20000	24.63084	-0.4308442
290	15.20000	23.04744	-7.847442
291	35.00000	32.66475	2.335249
292	20.00000	19.89798	0.1020148
293	25.00000	25.24861	-0.2486088
294	25.00000	25.39555	-0.3955537
295	15.00000	16.53304	-1.533045
296	22.00000	32.22198	-10.22199
297	20.30000	35.36171	-15.06172
298	32.00000	39.34931	-7.349319
299	25.00000	25.38609	-0.3860870
300	27.00000	35.06900	-8.069002
301	21.00000	23.04744	-2.047441
302	51.00000	49.39324	1.606755
303	28.70000	35.82977	-7.129778
304	42.50000	43.00751	-0.5075196
305	39.50000	31.18410	8.315891
306	9.500000	40.70773	-31.20773
307	28.70000	24.98248	3.717519
308	76.84999	32.69906	44.15092
309	48.00000	30.48356	17.51644



J-1 (Contd.)

Plot of standardised residuals and table of observed and predicted values for total data matrix with respect to the variable E

310	40.00000	39.71141	0.2883872
311	42.00000	30.85275	11.14725
312	54.00000	53.73401	0.2659873
313	35.00000	37.82236	-2.822368
314	60.16000	41.55106	18.60892
315	30.00000	27.66664	2.333361
316	40.00000	42.98988	-2.989885
317	40.00000	33.52028	6.479715
318	40.00000	50.00542	-10.00543
319	38.00000	48.32443	-10.32444
320	29.50000	47.75204	-18.25205
321	37.50000	22.66361	14.83639
322	24.00000	33.86182	-9.861830
323	72.50000	37.03825	35.46175
324	32.70000	35.62827	-2.928275
325	36.00000	28.16644	7.833555
326	31.80000	24.98248	6.817521
327	25.24000	29.23225	-3.992260
328	20.00000	20.55976	-0.5597605
329	40.00000	27.82956	12.17044
330	10.70000	17.87560	-7.175600
331	38.00000	23.79656	14.20343
332	54.56000	32.92690	21.63310
333	21.50000	29.39776	-7.897762
334	21.00000	34.43447	-13.43447
335	15.50000	23.79656	-8.296566
336	75.00000	55.02582	19.97417
337	73.00000	46.46543	26.53456
338	52.00000	20.55976	31.44024
339	44.30000	28.73927	15.56073
340	34.50000	34.16562	0.3343766
341	39.39999	37.22514	2.174845
342	46.00000	37.47341	8.526585
343	30.00000	30.72665	-0.7266524
344	20.00000	20.15823	-0.1582285
345	18.00000	21.11240	-3.112404
346	12.00000	22.07114	-10.07115
347	53.00000	35.17295	17.82705
348	53.50000	39.10613	14.39386
349	18.00000	23.04744	-5.047441
350	42.00000	36.19519	5.804803
351	20.00000	25.31982	-5.319822
352	26.20000	31.09616	-4.896165
353	16.50000	33.01074	-16.51075
354	13.50000	23.79656	-10.29657
355	40.50000	34.13273	6.367264
356	43.00000	38.58849	4.411505
357	30.00000	30.72665	-0.7266524
358	43.00000	39.71728	3.282715
359	22.00000	23.79656	-1.796566
360	30.50000	23.74632	6.753677
361	27.00000	30.90344	-3.903445
362	20.00000	23.04744	-3.047441



J-1 (Contd.)

Plot of standardised residuals and table of observed and predicted values for total data matrix with respect to the variable E

```
363     16.00000     27.69534     -11.69534        *     I
364     18.00000     27.13394     -9.133942          *   I
365     21.00000     39.86609     -18.86610     *        I
```

DURBIN-WATSON TEST OF RESIDUAL DIFFERENCES COMPARED BY CASE ORDER (SEQNUM).

VARIABLE LIST 1, REGRESSION LIST 1. DURBIN-WATSON TEST 1.81570

J-1 (Contd.)

Plot of standardised residuals and table of observed and predicted values for total data matrix with respect to the variable E

APPENDIX K

FILE F1 (CREATION DATE = 10/17/83)

* M U L T I P L E   R E G R E S S I O N * * * * * * * * * * * * * *   VARIABLE LIST 1
REGRESSION LIST 1

DEPENDENT VARIABLE.. T

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
M	0.28077	0.07883	0.07883	0.28077	3.691641	0.35329
L	0.30229	0.09138	0.01255	0.00184	-2.727961	-0.13449
Q	0.32436	0.10521	0.01383	0.21029	0.2582038	0.17141
N	0.34270	0.11745	0.01224	-0.10220	0.1422441	0.18557
I	0.34972	0.12230	0.00486	-0.03142	-1.988110	-0.07031
P	0.35121	0.12335	0.00105	-0.07210	-0.1553319	-0.06241
K	0.35247	0.12424	0.00089	0.06719	-0.4130603	-0.04479
O	0.35290	0.12454	0.00030	0.18691	0.4058982E-01	0.02575
(CONSTANT)					-0.8354534	

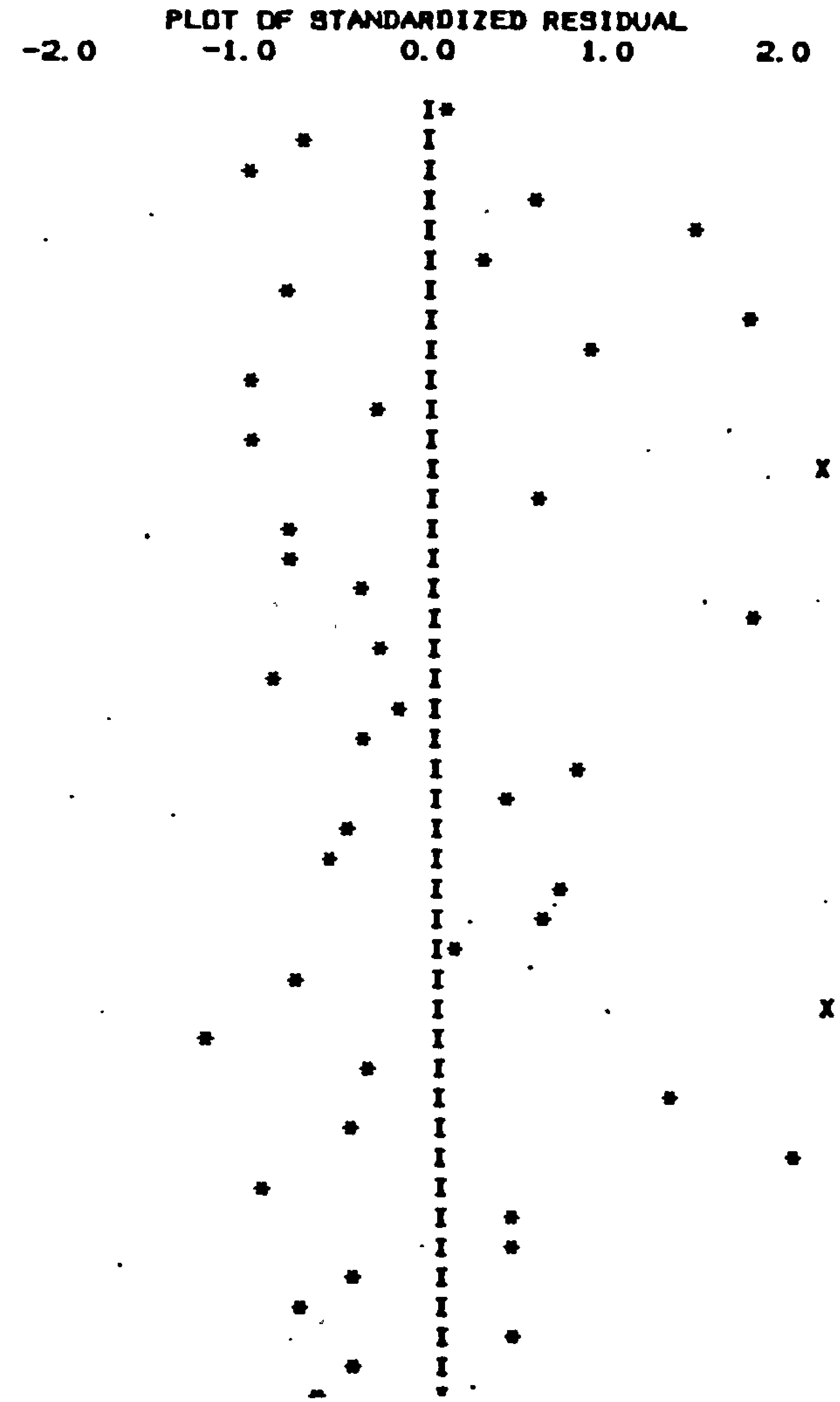
K-1

Multiple Regression Analysis - T with I to R for the Total Data Matrix

MULTIPLE REGRESSION

DEPENDENT VARIABLE: T FROM VARIABLE LIST 1
REGRESSION LIST 1

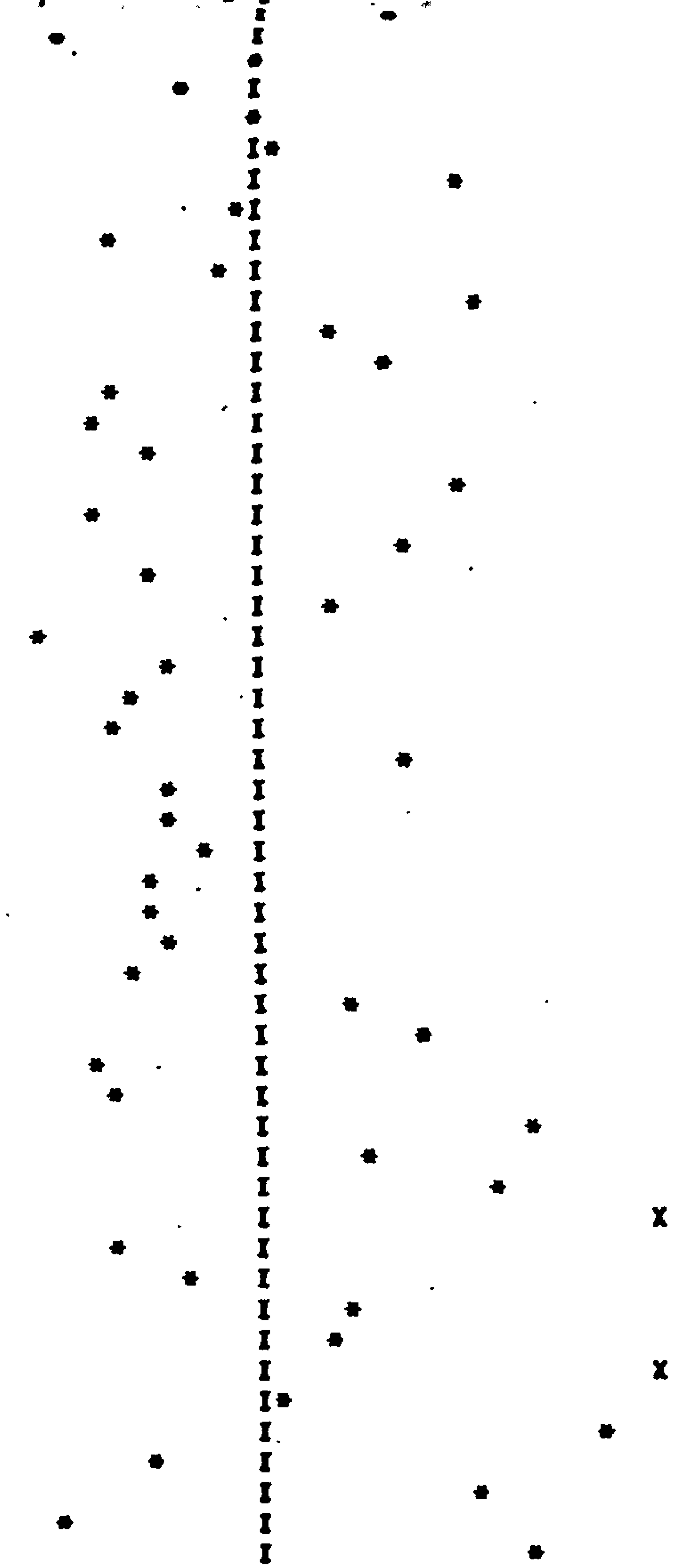
SEQNUM	OBSERVED T	PREDICTED T	RESIDUAL
1	15.00000	13.21615	1.783849
2	0.0000000	8.770456	-8.770458
3	0.0000000	13.34935	-13.34935
4	23.50000	15.73659	7.763412
5	33.00000	12.81308	20.18692
6	14.00000	10.50473	3.495270
7	2.000000	12.90818	-10.90818
8	40.00000	15.93084	24.06915
9	21.00000	8.523880	12.47612
10	0.0000000	13.88247	-13.88247
11	0.0000000	3.758568	-3.758569
12	0.0000000	13.12155	-13.12155
13	52.50000	13.56201	38.93798
14	22.00000	13.40864	8.591362
15	0.0000000	10.90412	-10.90412
16	0.0000000	11.17025	-11.17025
17	0.0000000	6.007179	-6.007180
18	38.00000	13.32982	24.67018
19	0.0000000	3.887645	-3.887647
20	0.0000000	12.30242	-12.30242
21	5.000000	7.732269	-2.732271
22	0.0000000	4.817540	-4.817541
23	17.00000	6.118917	10.88108
24	15.20000	10.31019	4.889807
25	0.0000000	6.618549	-6.618550
26	0.0000000	7.418487	-7.418488
27	16.70000	7.732269	8.967726
28	12.50000	4.630438	7.869560
29	8.000000	6.668091	1.331908
30	0.0000000	10.31019	-10.31019
31	65.00000	5.983646	59.01635
32	0.0000000	17.42068	-17.42069
33	14.50000	20.39773	-5.897733
34	25.00000	7.980790	17.01921
35	0.0000000	6.774379	-6.774380
36	42.00000	15.06709	26.93291
37	0.0000000	13.60180	-13.60180
38	5.000000	-0.8001105E-01	5.080009
39	11.00000	5.040192	5.959806
40	0.0000000	7.358399	-7.358401
41	0.0000000	11.05069	-11.05069
42	15.00000	9.173903	5.826096
43	0.0000000	6.258921	-6.258923
44	0.0000000	9.029078	-9.029079



K-2

Plot of standardised residuals and table of observed and predicted values for total data matrix with respect to the variable T

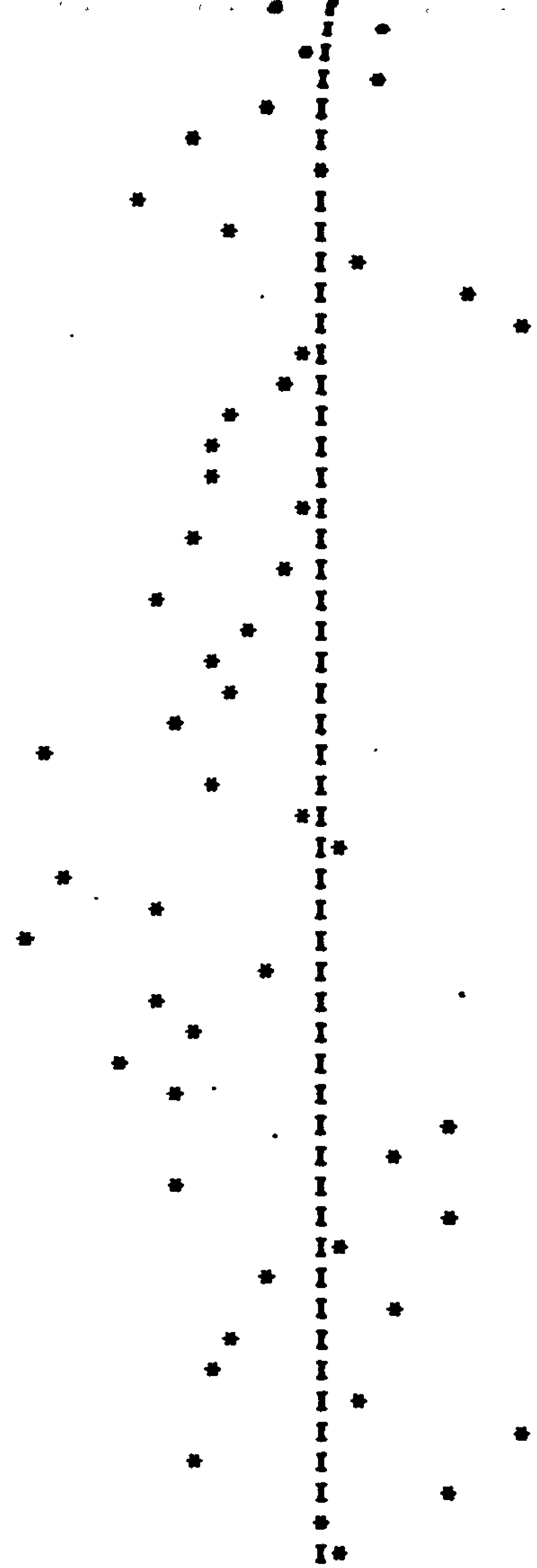
47	0.0000000	14.31244	-14.31244
48	8.000000	8.660091	-0.6600929
49	0.0000000	6.020000	-6.020000
50	15.20000	14.65129	0.5487070
51	17.00000	15.26913	1.730872
52	27.00000	11.98813	15.01186
53	9.000000	10.90081	-1.900812
54	0.0000000	10.59015	-10.59015
55	10.50000	13.64999	-3.149994
56	33.00000	16.43024	16.56976
57	32.00000	26.29668	5.703312
58	29.00000	19.57206	9.427935
59	0.0000000	10.31019	-10.31019
60	0.0000000	12.32433	-12.32434
61	0.0000000	7.856165	-7.856166
62	28.00000	13.75947	14.24053
63	0.0000000	12.26846	-12.26846
64	21.00000	10.31019	10.68981
65	8.000000	16.54994	-8.549942
66	15.50000	10.75719	4.742810
67	0.0000000	15.42026	-15.42027
68	0.0000000	6.584913	-6.584914
69	0.0000000	9.263462	-9.263464
70	0.0000000	11.01492	-11.01492
71	21.00000	10.37307	10.62693
72	0.0000000	7.126612	-7.126613
73	0.0000000	6.551813	-6.551814
74	6.000000	9.599846	-3.599847
75	0.0000000	8.034496	-8.034498
76	0.0000000	8.368368	-8.368370
77	0.0000000	6.618549	-6.618550
78	0.0000000	9.210712	-9.210714
79	15.50000	9.055605	6.444392
80	23.00000	10.31019	12.68981
81	1.500000	13.96432	-12.46432
82	5.000000	15.13307	-10.13308
83	28.00000	7.619872	20.38013
84	15.00000	7.408364	7.591635
85	25.00000	6.964873	18.03513
86	41.00000	10.75719	30.24281
87	0.0000000	10.75719	-10.75719
88	20.00000	25.16307	-5.163074
89	22.39999	15.88632	6.513672
90	16.89999	11.75607	5.143927
91	48.25000	10.02616	38.22384
92	11.00000	10.31019	0.6898087
93	40.70000	14.95433	25.74567
94	0.0000000	7.413169	-7.413170
95	30.07000	13.63796	16.43204
96	0.0000000	15.12897	-15.12897
97	33.63000	13.50520	20.12479



K-2 (Contd.)

Plot of standardised residuals and table of observed and predicted values for total data matrix with respect to the variable T

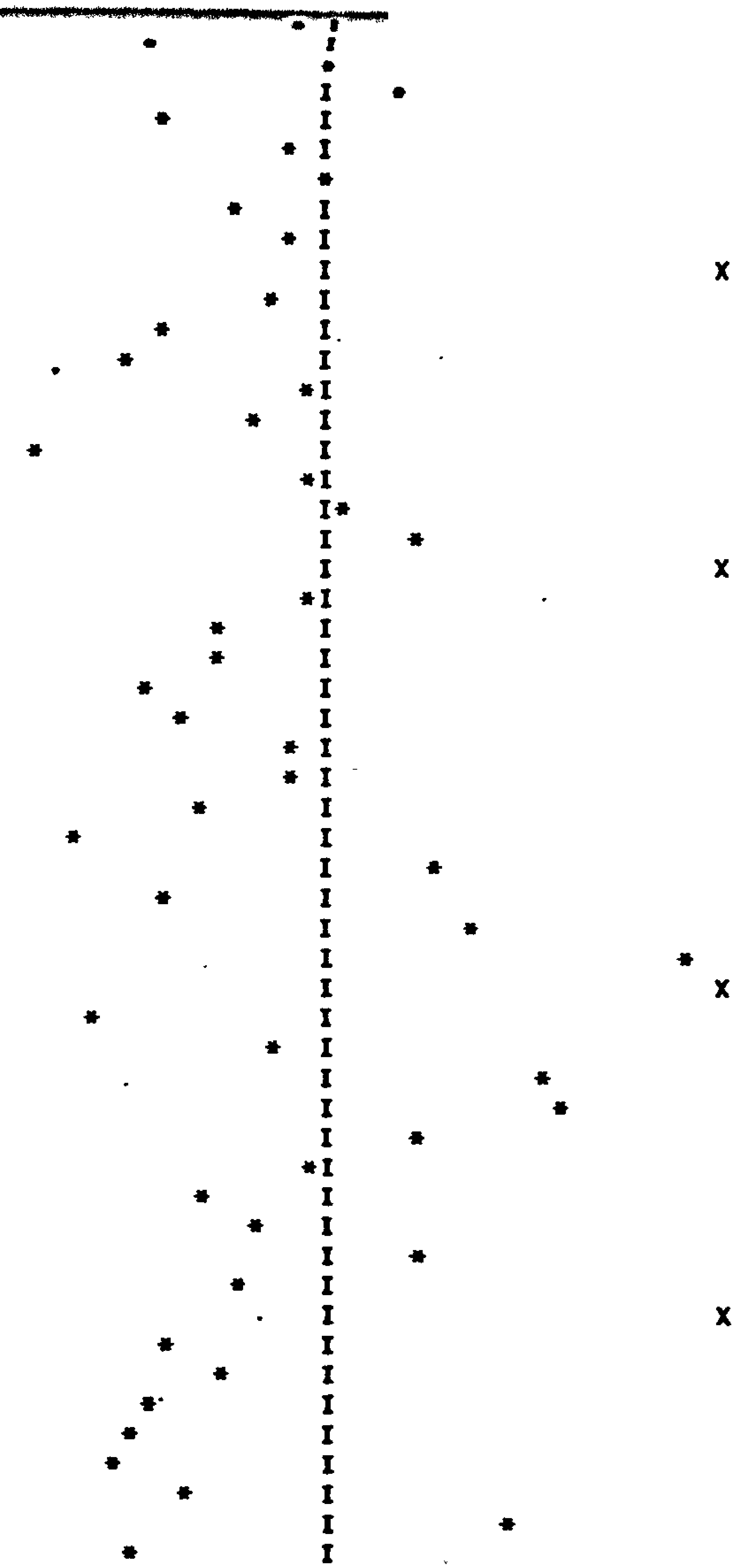
100	14.00000	10.31019	3.689808
101	11.00000	11.97003	-0.9700296
102	10.00000	6.618549	3.381450
103	9.500000	13.72292	-4.222921
104	0.0000000	9.720379	-9.720383
105	8.000000	8.504761	-0.5047611
106	0.0000000	13.03815	-13.03815
107	0.0000000	7.031610	-7.031610
108	12.00000	9.346510	2.653489
109	22.00000	10.72325	11.27675
110	26.50000	11.22845	15.27155
111	7.500000	8.735140	-1.235141
112	8.000000	10.31019	-2.310192
113	6.000000	12.95631	-6.956312
114	2.000000	10.31019	-8.310192
115	0.0000000	7.771461	-7.771461
116	12.00000	13.17339	-1.173389
117	0.0000000	8.794157	-8.794159
118	5.279999	8.322081	-3.042082
119	0.0000000	12.49821	-12.49822
120	0.0000000	4.727086	-4.727087
121	8.000000	16.40068	-8.400682
122	0.0000000	6.149635	-6.149636
123	0.0000000	11.32375	-11.32375
124	0.0000000	20.13027	-20.13028
125	11.00000	18.74704	-7.747042
126	10.00000	11.94508	-1.945081
127	11.00000	10.04214	0.9578574
128	0.0000000	18.55196	-18.55197
129	0.0000000	12.17965	-12.17965
130	3.000000	24.69659	-21.69659
131	21.27000	25.16481	-3.894810
132	0.0000000	12.63943	-12.63943
133	0.0000000	9.245947	-9.245949
134	0.0000000	14.40583	-14.40583
135	0.0000000	10.31019	-10.31019
136	17.00000	7.508826	9.491171
137	20.00000	15.01432	4.985676
138	0.0000000	10.34413	-10.34413
139	30.00000	20.08298	9.917013
140	11.00000	9.378279	1.621719
141	0.0000000	4.521342	-4.521343
142	12.00000	6.099698	5.900300
143	0.0000000	7.343336	-7.343337
144	0.0000000	8.211746	-8.211748
145	10.00000	7.430869	2.569130
146	25.00000	10.72325	14.27675
147	4.000000	12.84865	-8.848648
148	15.00000	6.201698	8.798300
149	4.500000	4.065632	0.4343666
150	7.000000	5.821221	1.178778



K-2 (Contd.)

Plot of standardised residuals and table of observed and predicted values for total data matrix with respect to the variable T

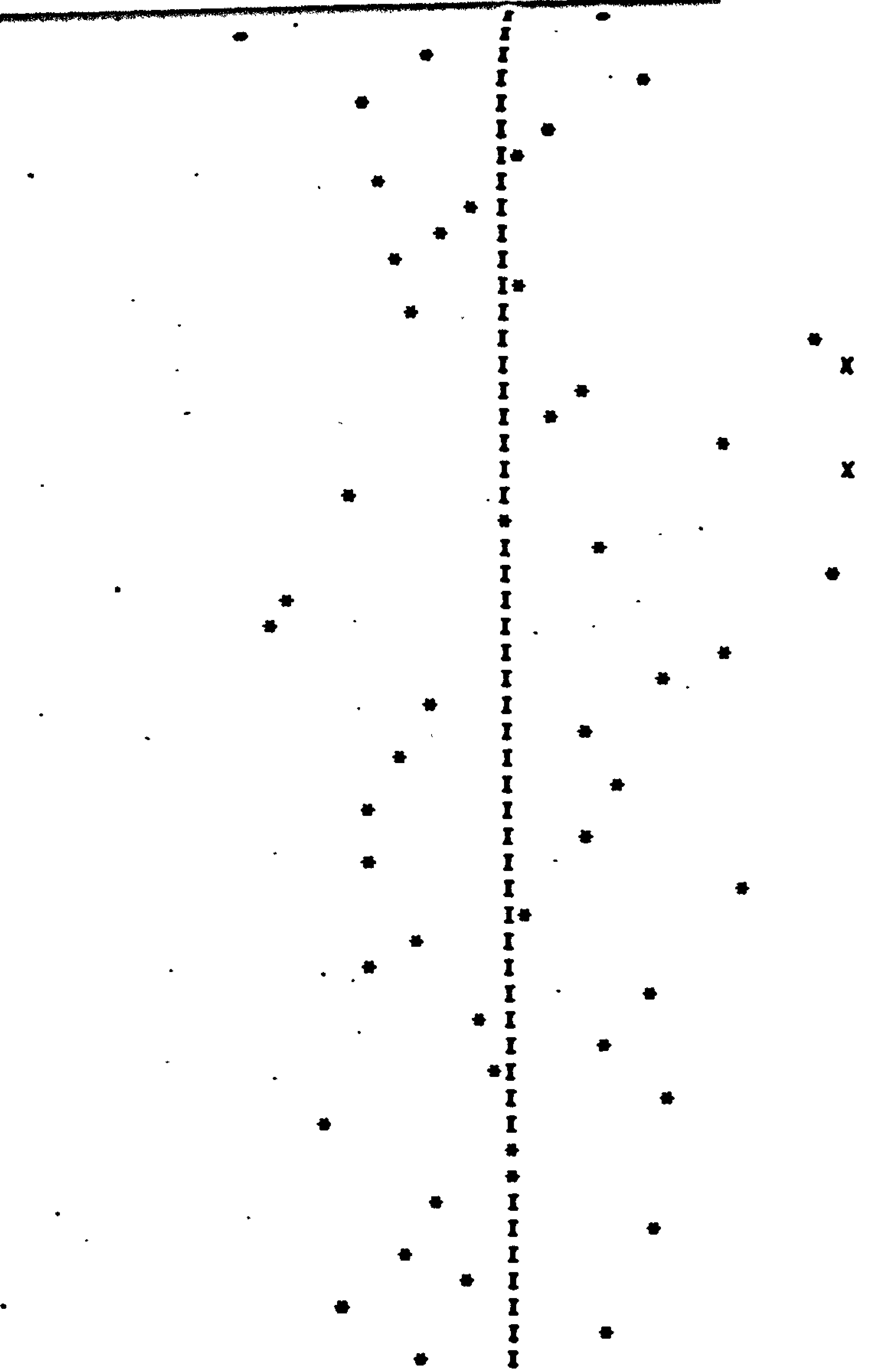
151	0.0000000	[illegible]	-3.310377	
152	0.0000000	13.17449	-13.17449	
153	0.0000000	0.3330497	-0.3330505	
154	13.00000	7.511137	5.488862	
155	0.0000000	12.60986	-12.60986	
156	5.000000	7.343336	-2.343337	
157	0.0000000	-0.8001105E-01	0.8000986E-01	
158	0.0000000	6.792316	-6.792317	
159	0.0000000	2.120171	-2.120172	
160	60.00000	10.31456	49.68543	X
161	0.0000000	4.521342	-4.521343	
162	0.0000000	11.68618	-11.68618	
163	0.0000000	14.36311	-14.36311	
164	21.00000	22.60483	-1.604836	
165	0.0000000	5.594119	-5.594120	
166	0.5000000	21.57206	-21.07206	
167	25.00000	26.36835	-1.368357	
168	15.50000	13.72252	1.777483	
169	15.00000	8.150021	6.849976	
170	60.00000	14.14830	45.85169	X
171	8.000000	9.720379	-1.720381	
172	0.0000000	8.322081	-8.322083	
173	0.0000000	7.582229	-7.582231	
174	0.0000000	13.77087	-13.77087	
175	0.0000000	11.33993	-11.33993	
176	12.00000	14.72001	-2.720014	
177	6.000000	8.735140	-2.735141	
178	0.0000000	9.415173	-9.415174	
179	0.0000000	19.07702	-19.07703	
180	35.00000	26.88626	8.113735	
181	0.0000000	11.46310	-11.46310	
182	33.00000	21.65521	11.34479	
183	34.50000	8.145330	26.35467	
184	56.00000	21.14664	34.85336	X
185	0.0000000	17.29890	-17.29890	
186	16.50000	19.98467	-3.484672	
187	30.00000	13.89938	16.10061	
188	26.00000	8.838488	17.16151	
189	16.00000	9.170012	6.829987	
190	8.500000	9.346510	-0.8465110	
191	0.0000000	9.058624	-9.058626	
192	5.000000	9.764877	-4.764879	
193	15.00000	8.402363	6.597635	
194	0.0000000	6.618549	-6.618550	
195	55.00000	16.21247	38.78753	X
196	7.000000	19.07084	-12.07084	
197	0.0000000	8.047644	-8.047646	
198	0.0000000	13.22424	-13.22424	
199	0.0000000	14.74628	-14.74628	
200	0.0000000	16.15863	-16.15863	
201	7.000000	17.28104	-10.28104	
202	25.00000	11.73041	13.26959	
203	0.0000000	14.15484	-14.15484	



K-2 (Contd.)

Plot of standardised residuals and table of observed and predicted values for total data matrix with respect to the variable T

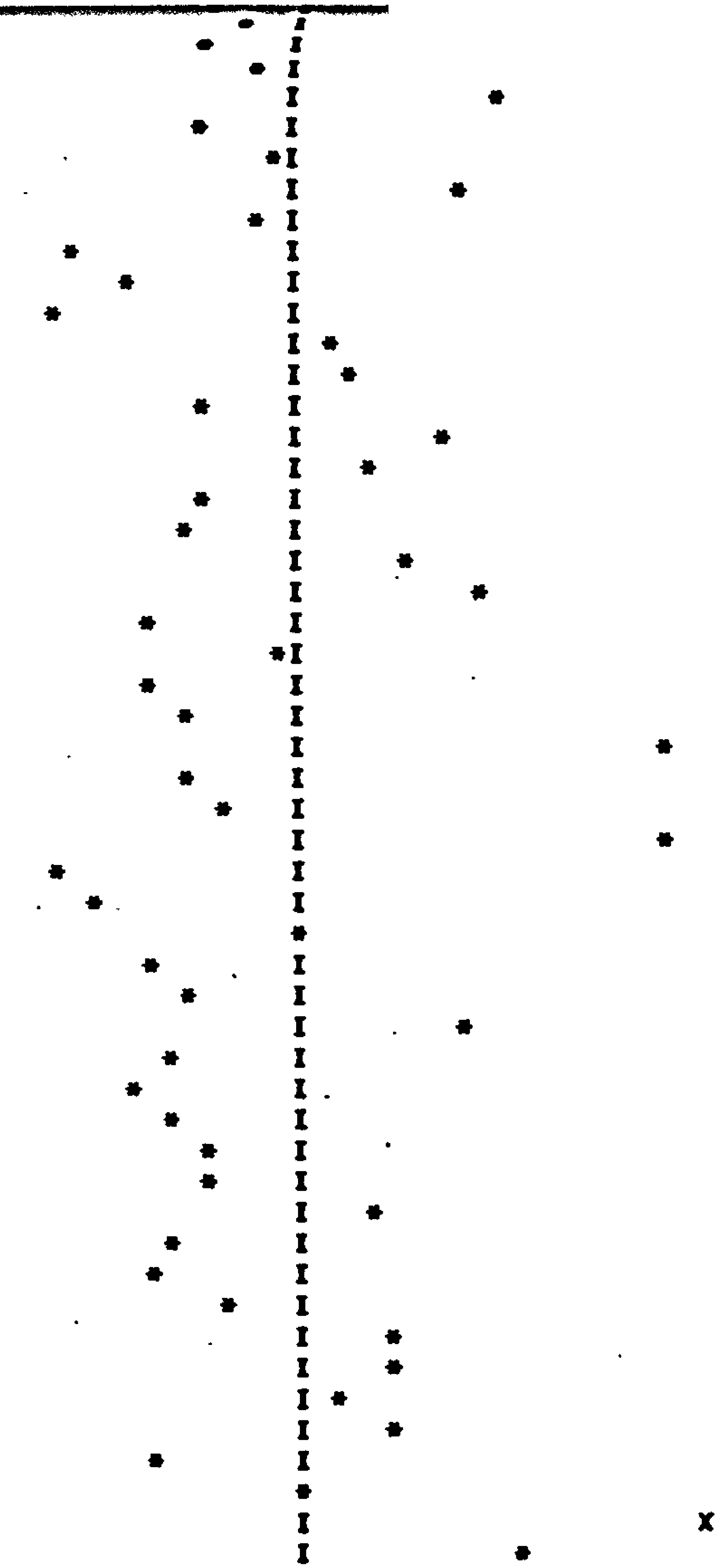
205	0.0000000	22.31921	-22.31921
206	0.0000000	6.856050	-6.856052
207	20.00000	7.582229	12.41777
208	0.0000000	11.46874	-11.46874
209	15.00000	11.05962	3.940382
210	12.00000	10.72325	1.276748
211	0.0000000	11.28029	-11.28029
212	5.500000	8.654726	-3.154727
213	5.000000	10.69230	-5.692299
214	0.0000000	9.931068	-9.931070
215	10.00000	8.388474	1.611525
216	0.0000000	8.322081	-8.322083
217	50.00000	23.22595	26.77404
218	51.00000	18.09338	32.90662
219	25.00000	17.99292	7.007074
220	17.50000	13.28025	4.219748
221	40.00000	20.73013	19.26987
222	51.00000	18.36266	32.63734
223	0.0000000	13.03815	-13.03815
224	16.00000	16.07258	-0.7258181E-01
225	30.00000	21.37715	8.622845
226	41.00000	13.02143	27.97857
227	15.00000	33.11741	-18.11742
228	0.0000000	20.37715	-20.37716
229	26.30000	7.446117	18.85388
230	22.00000	9.192240	12.80776
231	5.000000	11.75594	-6.755942
232	14.00000	7.031610	6.968390
233	0.0000000	9.157776	-9.157778
234	25.00000	15.27057	9.729427
235	0.0000000	11.58586	-11.58586
236	20.00000	13.53461	6.465388
237	0.0000000	11.42798	-11.42798
238	30.00000	9.608608	20.39139
239	12.00000	10.31019	1.689809
240	0.0000000	7.582229	-7.582231
241	0.0000000	12.18223	-12.18223
242	33.00000	21.31343	11.68656
243	7.400001	10.31019	-2.910191
244	20.00000	12.40017	7.599833
245	5.000000	5.792429	-0.7924292
246	21.50000	8.153938	13.34606
247	0.0000000	15.84905	-15.84905
248	19.00000	18.62833	0.3716646
249	9.000000	9.484070	-0.4840706
250	4.000000	10.75719	-6.757190
251	23.00000	10.75719	12.24281
252	0.0000000	9.678608	-9.678610
253	0.0000000	4.491146	-4.491148
254	0.0000000	14.39552	-14.39552
255	12.25000	3.804318	8.445681
256	2.000000	10.65479	-8.654795



K-2 (Contd.)

Plot of standardised residuals and table of observed and predicted values for total data matrix with respect to the variable T

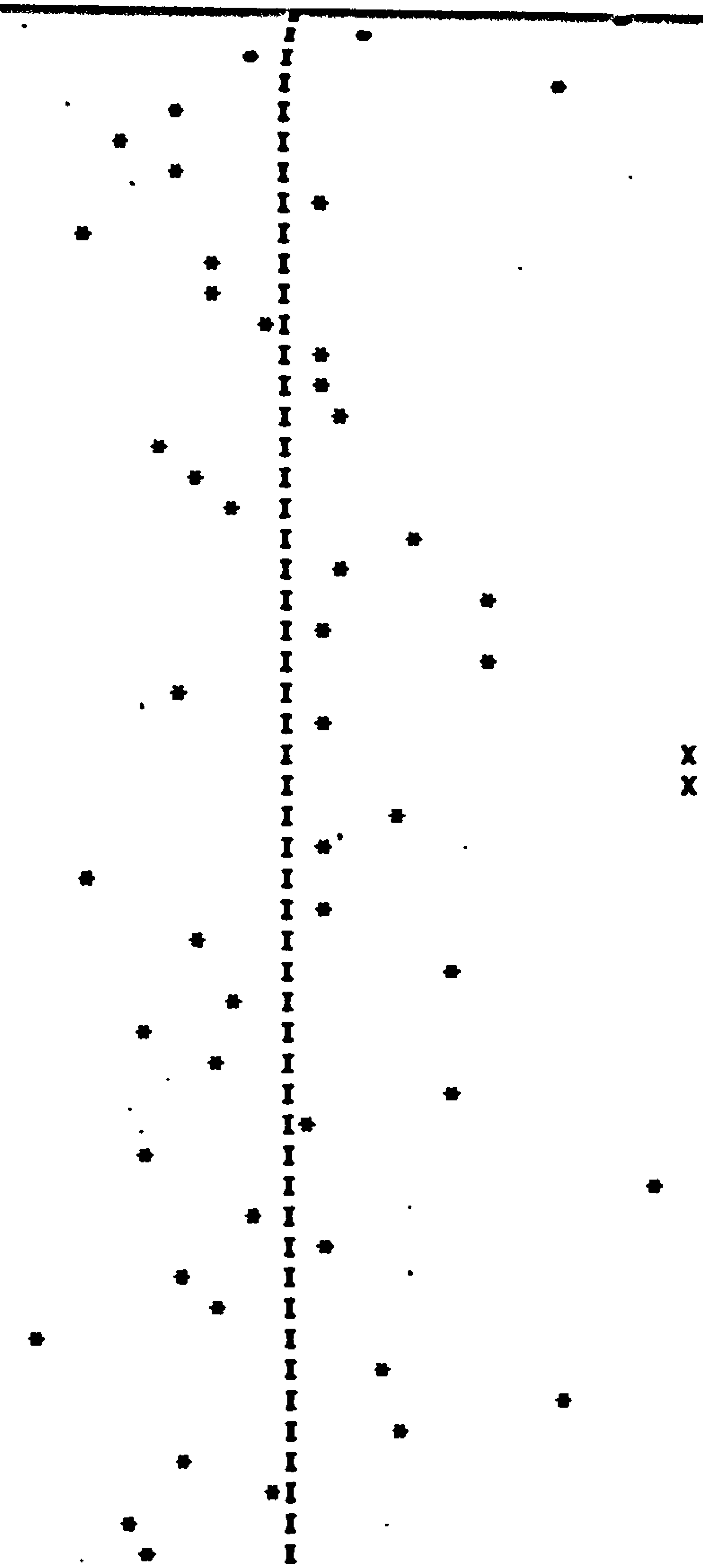
259	0.0000000	4.630438	-4.630440
260	0.0000000	6.305442	-6.305444
261	3.000000	5.808253	-2.808254
262	24.60000	9.694489	14.90551
263	6.000000	12.16900	-6.169003
264	15.00000	15.72802	-0.7280172
265	25.74000	13.05909	12.68091
266	0.0000000	3.136786	-3.136788
267	0.0000000	16.15049	-16.15049
268	0.0000000	12.26113	-12.26113
269	0.0000000	16.94969	-16.94969
270	23.98000	21.26885	2.711140
271	20.00000	15.60232	4.397674
272	0.0000000	6.029608	-6.029610
273	20.50000	9.846594	10.65340
274	16.00000	10.34413	5.655870
275	0.0000000	6.299539	-6.299541
276	0.0000000	8.668953	-8.668955
277	20.00000	12.09212	7.907881
278	29.15000	15.53940	13.61060
279	10.00000	20.55495	-10.55496
280	10.00000	11.37694	-1.376944
281	0.0000000	10.64821	-10.64821
282	0.0000000	8.384817	-8.384819
283	34.00000	7.835320	26.16468
284	0.0000000	7.501974	-7.501976
285	0.0000000	5.035014	-5.035015
286	51.59000	24.59624	26.99376
287	0.0000000	17.57992	-17.57993
288	0.0000000	14.25724	-14.25724
289	8.999998	8.821928	0.1780695
290	0.1999989	10.31019	-10.11019
291	5.000000	13.47951	-8.479511
292	20.00000	7.995290	12.00471
293	0.0000000	8.890865	-8.890867
294	0.0000000	11.41974	-11.41974
295	0.0000000	9.346510	-9.346512
296	5.000000	11.80042	-6.800426
297	10.15000	17.41708	-7.267085
298	22.00000	16.38268	5.617320
299	0.0000000	9.170012	-9.170013
300	2.000000	12.43240	-10.43240
301	4.500000	10.31019	-5.810192
302	21.00000	14.70043	6.299567
303	21.70000	14.71649	6.983504
304	23.00000	20.73874	2.261259
305	19.50000	12.17965	7.320347
306	0.0000000	10.44748	-10.44748
307	10.50000	9.897129	0.6028690
308	76.84999	13.38964	63.46034
309	30.00000	13.52456	16.47544



K-2 (Contd.)

Plot of standardised residuals and table of observed and predicted values for total data matrix with respect to the variable T

311	42.00000	18.20235	23.79764
312	32.00000	26.62952	5.370472
313	10.00000	12.94618	-2.946184
314	27.33000	7.430243	19.89976
315	0.0000000	7.495959	-7.495960
316	0.0000000	11.48538	-11.48538
317	0.0000000	7.466104	-7.466105
318	20.00000	17.29398	2.706018
319	0.0000000	14.65420	-14.65420
320	9.500000	14.49887	-4.998867
321	0.0000000	5.004309	-5.004310
322	12.00000	12.67192	-0.6719172
323	7.000000	4.394974	2.605026
324	16.00000	13.46902	2.530976
325	12.50000	8.410748	4.089250
326	0.0000000	9.897129	-9.897131
327	5.239998	12.17152	-6.931528
328	0.0000000	4.217378	-4.217380
329	15.00000	5.504541	9.495457
330	10.70000	6.618549	4.081449
331	23.00000	8.322081	14.67792
332	10.00000	6.896148	3.103851
333	21.50000	6.964873	14.53513
334	0.0000000	7.482231	-7.482233
335	11.50000	8.322081	3.177919
336	50.00000	15.03878	34.96121
337	50.00000	10.08735	39.91264
338	12.00000	4.217378	7.782620
339	15.80000	12.54230	3.257694
340	0.0000000	14.71591	-14.71591
341	12.39999	9.073162	3.326830
342	9.000000	15.98967	-6.989669
343	22.50000	10.02261	12.47739
344	0.0000000	3.797617	-3.797619
345	0.0000000	10.72325	-10.72325
346	0.0000000	5.329690	-5.329692
347	28.00000	15.64848	12.35152
348	16.00000	15.31793	0.6820710
349	0.0000000	10.31019	-10.31019
350	42.00000	15.47074	26.52926
351	0.0000000	3.052647	-3.052648
352	16.20000	12.93731	3.262691
353	5.000000	12.49031	-7.490317
354	3.500000	8.322081	-4.822082
355	0.0000000	18.20283	-18.20284
356	20.00000	12.70849	7.291509
357	30.00000	10.02261	19.97739
358	20.00000	12.33224	7.667760
359	0.0000000	8.322081	-8.322083
360	3.500000	4.591249	-1.091249
361	0.0000000	11.60066	-11.60066
362	0.0000000	10.31019	-10.31019



K-2 (Contd.)

Plot of standardised residuals and table of observed and predicted values for total data matrix with respect to the variable T

```
363     0.0000000     5.044562    -5.044563                    *   I
364     0.0000000     2.897315    -2.897316                       * I
365      11.00000     18.88237    -7.882371                 *       I
```

DURBIN-WATSON TEST OF RESIDUAL DIFFERENCES COMPARED BY CASE ORDER (SEQNUM).

VARIABLE LIST 1. REGRESSION LIST 1. DURBIN-WATSON TEST 1.94030

K-2 (Contd.)

Plot of standardised residuals and table of observed and predicted values for total data matrix with respect to the variable T

APPENDIX L

FILE F1 (CREATION DATE = 06/01/83)

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * * * * VARIABLE LIST 1
REGRESSION LIST 1

DEPENDENT VARIABLE.. F

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
K	(0.27) 0.56980	0.32467	0.32467	0.56980	[illegible]	[illegible]
N	(0.38) 0.68459	0.46867	0.14400	-0.45681	[illegible]	[illegible]
R	(0.47) 0.76695	0.58821	0.11955	0.44965	0.1839076	[illegible]
L	(0.71) 0.89361	0.79853	0.21032	0.53729	-2.740827	[illegible]
Q	(0.76) 0.91834	0.84335	0.04482	0.19372	[illegible]	[illegible]
P	(0.80) 0.93062	0.86605	0.02270	-0.54050	[illegible]	[illegible]
M	(0.82) 0.95357	0.90929	0.04325	0.40150	[illegible]	[illegible]
J	(0.82) 0.96047	0.92250	0.01321	0.43742	[illegible]	[illegible]
S	(0.83) 0.96802	0.93707	0.01457	0.54855	-0.1658544E-0?	[illegible]
I	(0.88) 0.97589	0.95235	0.01528	0.26345	0.3556034	0.47547
O	0.97626	0.95309	0.00074	0.52896	0.473634E-0?	[illegible]
(CONSTANT)					1.601586	

L-1

Multiple Regression Analysis - F with I to S; F with B, D; B with I to S; D with I to S for Means Data Matrix

FILE F1 (CREATION DATE = 06/01/83)

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * * VARIABLE LIST 1
REGRESSION LIST [illegible]

DEPENDENT VARIABLE.. F

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
D	(0.67)0.33335	0.69448	0.69448	0.83335	0.[illegible]3131[illegible]E- 1	[illegible]
[illegible]	(0.85)0.93184	0.86833	0.17366	[illegible]77	[illegible]623[illegible]	[illegible]
(CONSTANT)					-0.[illegible]07032	

L-1 (Contd.)

Multiple Regression Analysis - F with I to S; F with B, D; B with I to S; D with I to S for Means Data Matrix

FILE F1 (CREATION DATE = 06/01/83)

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * * * VARIABLE LIST 1
REGRESSION LIST 1

DEPENDENT VARIABLE.. B

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
P	0.58225	0.33901	0.33901	-0.58225	-0.10270[illegible]	-1.51[illegible]
S	0.69030	0.47652	0.13751	0.51912	[illegible]	[illegible]
R	0.76062	0.57804	0.10232	0.45352	0.[illegible]2688416E-01	1.04[illegible]71
J	0.86092	0.74118	0.16234	0.75558	-0.2557764	-0.45775
I	0.89235	0.79628	0.05511	0.21859	-0.[illegible]9065[illegible]E-[illegible]	-0.015[illegible]
O	0.91868	0.84397	0.04770	0.40428	0.2873226E-01	0.78011
L	0.95166	0.90565	0.06169	0.48043	-0.42203[illegible]1	-0.9[illegible]536
Q	0.96670	0.93450	0.02885	0.11504	0.1451546E-01	0.28374
N	0.96782	0.93667	0.00216	-0.33447	0.6168294E-0[illegible]	0.53014
K	0.96961	0.94014	0.00347	0.48654	-0.1092457	-0.658[illegible]
M	0.97419	0.94904	0.00850	0.28501	-0.8496554E-01	-0.27262
(CONSTANT)					1.488272	

L-1 (Contd.)

Multiple Regression Analysis - F with I to S; F with B, D; B with I to S; D with I to S for Means Data Matrix

FILE F1 (CREATION DATE = 06/01/83)

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * * VARIABLE LIST 1
REGRESSION LIST 4

DEPENDENT VARIABLE.. D

SUMMARY TABLE

VARIABLE		MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
L	(0.42)	0.67835	0.46016	0.46016	0.67835	-47.55540	-3.15443
N	(0.50)	0.75812	0.57474	0.11458	-0.51893	-0.5579348	-1.37478
K	(0.55)	0.80323	0.64518	0.07045	0.67702	10.50481	2.25513
R	(0.66)	0.87194	0.76029	0.11510	0.42159	3.027147	1.08766
Q	(0.74)	0.91168	0.83116	0.07087	0.36715	0.7125743	0.12477
I	(0.73)	0.91901	0.84459	0.01343	0.44875	9.337962	0.47082
M	(0.71)	0.92557	0.85668	0.01209	0.48917	6.079724	0.77509
S	(0.72)	0.93863	0.88102	0.02434	0.43915	-0.8041504E-01	-0.65570
O	(0.77)	0.95721	0.91625	0.03523	0.57537	-0.7191171	-0.43350
J	(0.72)	0.95947	0.92058	0.00433	0.48246	7.059780	0.29957
P	(0.64)	0.96077	0.92309	0.00251	-0.58053	-0.3963948	-0.17278
(CONSTANT)						21.84061	

L-1 (Contd.)

Multiple Regression Analysis - F with I to S; F with B, D; B with I to S; D with I to S for Means Data Matrix

```
* * * * * * * * * * * * * * * * * * * * * * *   M U L T I P L E   R E G R E S S I O N   * * * * * * * * * * * * * * *

DEPENDENT VARIABLE:  D          FROM    VARIABLE LIST  1
                                        REGRESSION LIST  4

                                                                               PLOT OF STANDARDIZED RESIDUAL
SEQNUM      OBSERVED         PREDICTED          RESIDUAL             -2.0     -1.0        0.0       1.0
              D                D

   1       17.90000         17.50240        0.3975939                                      I*
   2       17.00000         16.78306        0.2169359                                      I*
   3       15.70000         14.81664        0.8812187                                      I   *
   4       21.00000         23.27415       -2.274150                          *            I
   5       13.90000         13.77143        0.1285637                                      *
   6       28.20000         26.84993        1.350066                                       I       *
   7       20.80000         21.02334       -0.2233408                                     *I
   8       21.60000         22.74578       -1.145763                                 *     I
   9       18.70000         18.84806       -0.1480633                                     *I
  10       18.50000         17.81947        0.6805334                                      I  *
  11       26.30000         24.50392        1.796379                                       I         *
  12       28.10000         26.78935        1.310645                                       I       *
  13       16.70000         17.08383       -0.3838364                                     *I
  14       25.80000         25.82056       -0.2056287E-01                                  *
  15       20.10000         21.96690       -1.866900                              *        I

DURBIN-WATSON TEST OF RESIDUAL DIFFERENCES COMPARED BY CASE ORDER (SEQNUM).

VARIABLE LIST  1, REGRESSION LIST  1.    DURBIN-WATSON TEST    2.52363
VARIABLE LIST  1, REGRESSION LIST  2.    DURBIN-WATSON TEST    1.69523
VARIABLE LIST  1, REGRESSION LIST  3.    DURBIN-WATSON TEST    2.09102
VARIABLE LIST  1, REGRESSION LIST  4.    DURBIN-WATSON TEST    1.78151
```

L-2

Plot of standardised residuals and table of observed and predicted values for means data with respect to variable D

FILE F1 (CREATION DATE = 06/02/83)

* M U L T I P L E   R E G R E S S I O N * * * * * * * * * * * * * VARIABLE LIST 1
REGRESSION LIST 1

DEPENDENT VARIABLE.. F

SUMMARY TABLE

VARIABLE		MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
S	(0.25)	0.54855	0.30090	0.30090	0.548[illegible]	[illegible]	[illegible]
R	(0.34)	0.68514	0.46941	0.16851	0.449[illegible]	0.1431[illegible]	1.15[illegible]14
N	(0.54)	0.82539	0.68127	0.21186	-0.45681	[illegible]	[illegible]
J	(0.54)	0.83895	0.70384	0.02257	0.43742	0.78422[illegible]E-01	0.07811
Q	(0.54)	0.85924	0.73830	0.03446	0.19372	0.2525[illegible]E-01	0.35[illegible]17
L	(0.54)	0.87323	0.76253	0.02423	0.53729	-0.8878173	-1.41[illegible]3[illegible]
P	(0.64)	0.90066	0.81120	0.04867	-0.54090	-0.7605032E-01	-0.79667
O	(0.64)	0.92242	0.85086	0.03967	0.52896	0.2547501E-01	0.42713
M	(0.54)	0.92401	0.85380	0.00294	0.40190	-0.4848[illegible]1[illegible]-01	-0.111[illegible]
(CONSTANT)						0.8984782	

L-3

Multiple Regression Analysis - F with J, L, M, N, O, P, Q, S; F with B, D; B with J, L, M, N, O, P, Q, S; D with J, L, M, N, O, P, Q, R, S for Means Data Matrix

FILE F1 (CREATION DATE = 06/02/83)

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * VARIABLE LIST 1
REGRESSION LIST 2

DEPENDENT VARIABLE.. F

SUMMARY TABLE

VARIABLE		MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
D	(o-wt)	0.83325	0.65448	0.65448	0.83325	[illegible]	[illegible]
B	(o-vs)	0.93184	0.86873	0.17366	0.88877	[illegible]	[illegible]
(CONSTANT)						[illegible]	

L-3 (Contd.)

Multiple Regression Analysis - F with J, L, M, N, O, P, Q, R, S; F with B, D; B with J, L, M, N, O, P, Q, R, S; D with J, L, M, N, O, P, Q, R, S for Means Data Matrix

```
FILE    F1      (CREATION DATE = 16/02/83)
* * * * * * * * * * * * * * * * * * * * *  M U L T I P L E   R E G R E S S I O N  * * * * * * * * * * * *   VARIABLE LIST  1
                                                                                                              REGRESSION LIST 3
DEPENDENT VARIABLE..   B
```

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
P	0.58225	0.33901	0.33901	-0.58225	-0.10364[illegible]	-1.5[illegible]
S	0.69030	0.47652	0.13751	0.51912	0.1654[illegible]E-0[illegible]	0.42162
R	0.76082	0.57864	0.10232	0.45592	0.10074[illegible]	1.154[illegible]
J	0.86092	0.74118	0.16233	0.75550	-0.16275[illegible]	-0.[illegible]5
O	0.89014	0.79225	0.05118	0.40428	0.3215[illegible]E-01	0.6474[illegible]
L	0.95011	0.90270	0.11035	0.46043	-0.7679687	-1.70[illegible]4
Q	0.96537	0.93193	0.02923	0.11504	0.1154215E-01	0.22567
N	0.96769	0.93642	0.00448	-0.33447	0.2359331E-02	0.12528
M	0.96843	0.93786	0.00145	0.26501	-0.2447121E-01	-0.07852
(CONSTANT)					1.552886	

L-3 (Contd.)

Multiple Regression Analysis - F with J, L, M, N, O, P, Q, R, S; F with B, D; B with J, L, M, N, O, P, Q, R, S; D with J, L, M, N, O, P, Q, R, S for Means Data Matrix

FILE F1 (CREATION DATE = [illegible])

. . . . M U L T I P L E   R E G R E S S I O N . . . . VARIABLE LIST 1
REGRESSION LIST 4

DEPENDENT VARIABLE.. D

SUMMARY TABLE

VARIABLE		MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
L	(c .42)	0.67835	0.46016	0.4601[illegible]	0.[illegible]76[illegible]	[illegible]	[illegible]
M	(c .50)	0.75812	0.57474	0.114[illegible]	-0.[illegible]18[illegible]	[illegible]	[illegible]
R	(c .54)	0.79909	0.63855	0.06381	0.421[illegible]	[illegible]	[illegible]
J	(c .62)	0.85226	0.72635	0.08780	0.7671[illegible]	[illegible]	[illegible]
S	(c .62)	[illegible]	0.75649	0.03014	[illegible]	[illegible]	[illegible]
O	(c .61)	0.88210	0.77809	0.02160	0.46246	[illegible]	[illegible]
P	(c .56)	0.88278	0.77930	0.00121	-0.[illegible]	[illegible]	[illegible]
(CONSTANT)						2.77[illegible]	

L-3 (Contd.)

Multiple Regression Analysis - F with J, L, M, N, O, P, Q, R, S; F with B, D; B with J, L, M, N, O, P, Q, R, S; D with J, L, M, N, O, P, Q, R, S for Means Data Matrix

```
* * * * * * * * * * * * * * * * * * * * * * *  M U L T I P L E   R E G R E S S I O N  * * * * * * * * * * * * *

DEPENDENT VARIABLE:  D          FROM    VARIABLE LIST  1
                                        REGRESSION LIST  4

          OBSERVED        PREDICTED                                       PLOT OF STANDARDIZED RESIDUAL
 SEQNUM      D               D            RESIDUAL              -2.0       -1.0        0.0        1.0        2.0

     1    17.90000        19.53827      -1.638273                              *    I
     2    17.00000        18.17181      -1.171810                               *   I
     3    15.70000        16.11562      -0.4156258                                 *I
     4    21.00000        23.42369      -2.423689                             *     I
     5    13.90000        11.46431       2.435688                                   I     *
     6    28.20000        23.10385       5.096147                                   I                 *
     7    20.80000        20.56146       0.2385333                                  I*
     8    21.60000        21.68332      -0.8332276E-01                              *
     9    18.70000        18.44008       0.2599106                                  I*
    10    18.50000        18.90478      -0.4047834                                 *I
    11    26.30000        24.97245       1.327546                                   I   *
    12    28.10000        27.86552       0.2344708                                  I*
    13    16.70000        19.15835      -2.458354                             *     I
    14    25.80000        23.77459       2.025404                                   I     *
    15    20.10000        23.12184      -3.021844                          *        I
```

DURBIN-WATSON TEST OF RESIDUAL DIFFERENCES COMPARED BY CASE ORDER (SEQNUM).

VARIABLE LIST 1, REGRESSION LIST 1.	DURBIN-WATSON TEST	1.28405
VARIABLE LIST 1, REGRESSION LIST 2.	DURBIN-WATSON TEST	1.69523
VARIABLE LIST 1, REGRESSION LIST 3.	DURBIN-WATSON TEST	2.35475
VARIABLE LIST 1, REGRESSION LIST 4.	DURBIN-WATSON TEST	1.84233

L-4

Plot of standardised residuals and table of observed and predicted values for means data with respect to variable D

FILE F1 (CREATION DATE = 06/02/83)

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * * VARIABLE LIST 1
REGRESSION LIST 1

DEPENDENT VARIABLE.. F

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
S	(0.25) 0.54855	0.30090	0.30090	0.54855	0.2272[illegible]E-[illegible]	0.40914
P	(0.57) 0.68988	0.46359	0.16269	-0.54050	-0.5036[illegible]57E-01	-0.52765
O	(0.43) 0.74550	0.55577	0.09218	0.52896	0.39211[illegible]E-01	0.56816
M	0.75272	0.56659	0.01082	0.40190	-0.7954794E-01	-0.18350
J	0.76151	0.57990	0.01331	0.43742	-0.2334742	-0.22553
L	0.76336	0.58273	0.00283	0.19372	-0.5168726E-02	-0.07[illegible]65
N	0.76475	0.58484	0.00212	-0.45681	0.2042275E-02	0.07863
(CONSTANT)					1.311159	

L-5

Multiple Regression Analysis - F with J, L, M, N, O, P, Q, S; F with B, D; B with J, L, M, N, O, P, Q, S; D with J, L, M, N, O, P, Q, S for Means Data Matrix

FILE F1 (CREATION DATE = 06/02/83)

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * * VARIABLE LIST 1
REGRESSION LIST [illegible]

DEPENDENT VARIABLE.. F

SUMMARY TABLE

VARIABLE		MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
[illegible]	(C-47)	0.83335	0.69446	0.69446	0.83335	[illegible]E-01	[illegible]
[illegible]	(C-VS)	0.93134	0.868[illegible]3	0.173[illegible]	0.80677	[illegible]	[illegible]
(CONSTANT)						-0.[illegible]	

L-5 (Contd.)

Multiple Regression Analysis - F with J, L, M, N, O, P, Q, S; F with B, D; B with J, L, M, N, O, P, Q, S; D with J, L, M, N, O, P, Q, S for Means Data Matrix

FILE F1 (CREATION DATE = 06/02/83)

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * * VARIABLE LIST 1
REGRESSION LIST 1

DEPENDENT VARIABLE.. B

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
P	(c.29) 0.58225	0.33901	0.33901	-0.58225	[illegible]	-1.21[illegible]
S	(d.39) 0.69030	0.47652	0.13751	0.51912	[illegible]	0.443[illegible]
O	(c.37) 0.71149	0.50622	0.02970	0.40428	[illegible]	0.77[illegible]
J	0.73045	0.53362	0.02739	0.35550	-0.4907165	[illegible]
N	0.78888	0.62234	0.08872	-0.73447	0.1232697E-01	0.5[illegible]
Q	(c.42) 0.81795	0.66905	0.04671	0.11504	[illegible]	-0.1[illegible]370
M	0.82177	0.67531	0.00626	0.38501	-0.479[illegible]E-01	[illegible]
L	0.82489	0.68044	0.00513	0.48043	-0.1198668	[illegible]
(CONSTANT)					1.826373	

L-5 (Contd.)

Multiple Regression Analysis - F with J, L, M, N, O, P, Q, S; F with B, D; B with J, L, M, N, O, P, Q, S; D with J, L, M, N, O, P, Q, S for Means Data Matrix

FILE F1 (CREATION DATE = 05/02/83)

* MULTIPLE REGRESSION * * * * * * * * * * * * * * VARIABLE LIST 1
REGRESSION LIST 4

DEPENDENT VARIABLE.. D

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R		BETA
L	(0.42) 0.67835	0.46016	0.46016	0.67835	15.1[illegible]	[illegible]
N	(0.60) 0.75812	0.57474	0.11458	-0.51893	-0.1559[illegible]	-0.24[illegible]
M	(0.50) 0.78116	0.61022	0.03548	0.48[illegible]17	-0.32[illegible]646	-0.[illegible]77
J	(0.50) 0.80240	0.64384	0.03362	0.48246	-14.63537	-0.[illegible]1
S	(0.48) 0.81756	0.66841	0.02457	0.43515	0.3220050E-01	0.[illegible]
P	0.82412	0.67917	0.01076	-0.58053	0.530[illegible]501	0.2[illegible]
Q	0.82523	0.68101	0.00185	0.36719	0.1023[illegible]	[illegible]
O	0.82612	0.68248	0.00146	0.57527	0.1362471	0.0[illegible]
(CONSTANT)					8.511834	

L-5 (Contd.)

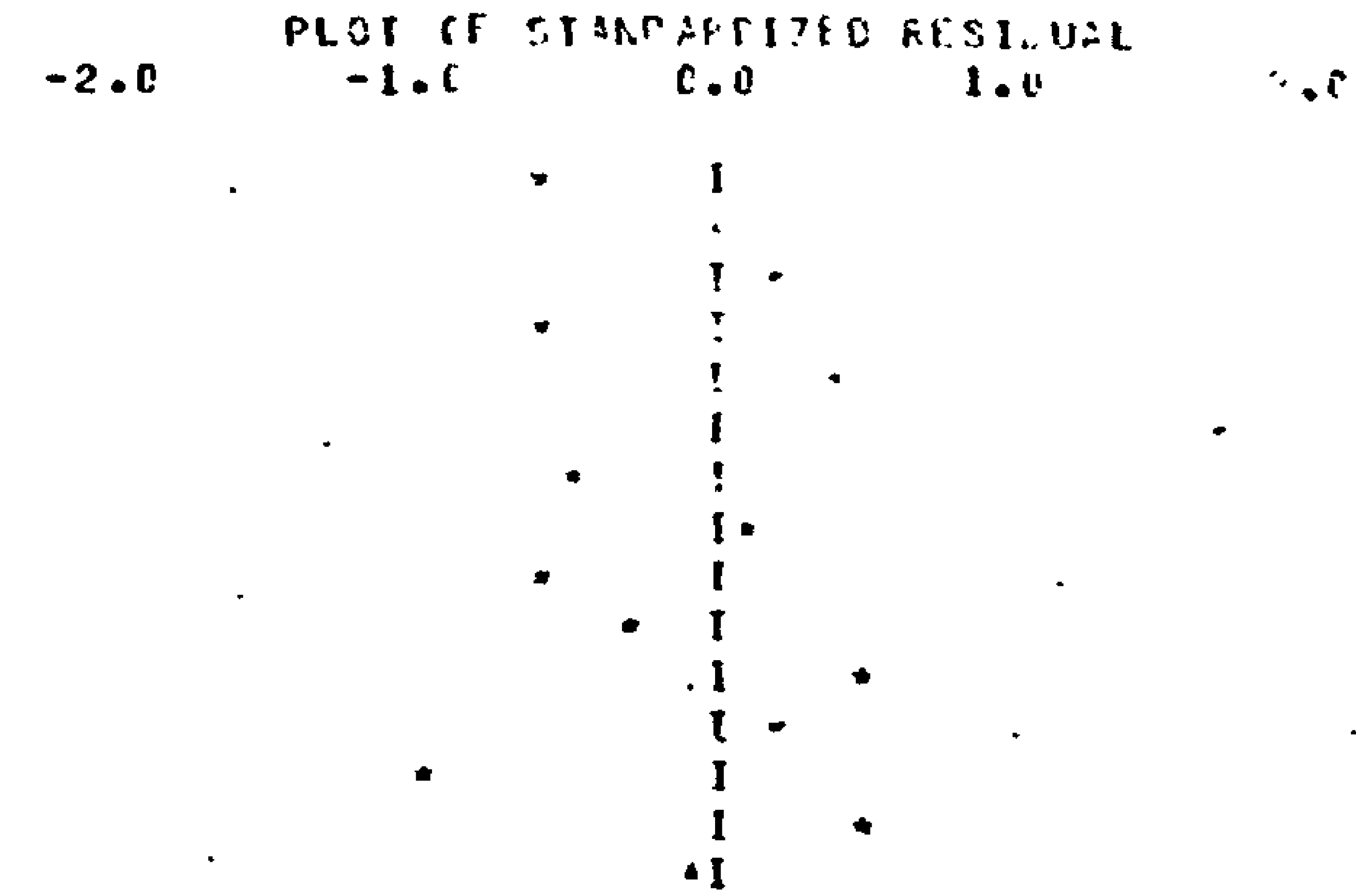
Multiple Regression Analysis - F with J, L, M, N, O, P, Q, S; F with B, D; B with J, L, M, N, O, P, Q, S; D with J, L, M, N, O, P, Q, S for Means Data Matrix

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * * *

DEPENDENT VARIABLE: D FROM VARIABLE LIST 1
REGRESSION LIST 4

SEQNUM	OBSERVED D	PREDICTED	RESIDUAL
1	17.90000	20.23693	-2.336930
2	17.00000	17.14100	-0.1405963
3	15.70000	14.70753	0.9124713
4	21.00000	23.16219	-2.162195
5	13.90000	12.22597	1.674033
6	28.20000	21.70280	6.497199
7	20.80000	22.65692	-1.856922
8	21.60000	21.15610	0.4438975
9	18.70000	20.98943	-2.289436
10	18.50000	19.72301	-1.223017
11	26.30000	24.17024	2.129755
12	28.10000	27.13632	0.9637717
13	16.70000	20.68114	-3.981148
14	25.80000	23.98130	1.818701
15	20.10000	20.54918	-0.4491867

PLOT OF STANDARDIZED RESIDUAL



DURBIN-WATSON TEST OF RESIDUAL DIFFERENCES COMPARED BY CASE ORDER (SEGNUM).

VARIABLE LIST 1,	REGRESSION LIST 1.	DURBIN-WATSON TEST	2.09591
VARIABLE LIST 1,	REGRESSION LIST 2.	DURBIN-WATSON TEST	1.69523
VARIABLE LIST 1,	REGRESSION LIST 3.	DURBIN-WATSON TEST	2.02900
VARIABLE LIST 1,	REGRESSION LIST 4.	DURBIN-WATSON TEST	2.33407

L-6

Plot of standardised residuals and table of observed and predicted values for means data with respect to variable D

APPENDIX M

FILE F1 (CREATION DATE = 10/06/83)

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * * VARIABLE LIST 1
REGRESSION LIST 1

DEPENDENT VARIABLE.. U

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
G	• 0.45760	0.20940	0.20940	-0.45760	-0.5965350	-0.25301
I	• 0.55388	0.30678	0.09738	0.29649	9.998565	0.26622
K	(0.25)• 0.59600	0.35522	0.04844	0.30589	4.816561	0.39694
R	0.60814	0.36984	0.01462	-0.37696	-1.381731	-0.37324
M	0.61713	0.38085	0.01101	0.26937	15.46823	0.82828
O	0.66964	0.44842	0.06757	0.05482	-1.229967	-0.59959
P	0.69518	0.48327	0.03485	-0.29908	1.714625	0.53958
L	0.69550	0.48371	0.00044	0.08549	-0.7270009	-0.02321
(CONSTANT)					7.791454	

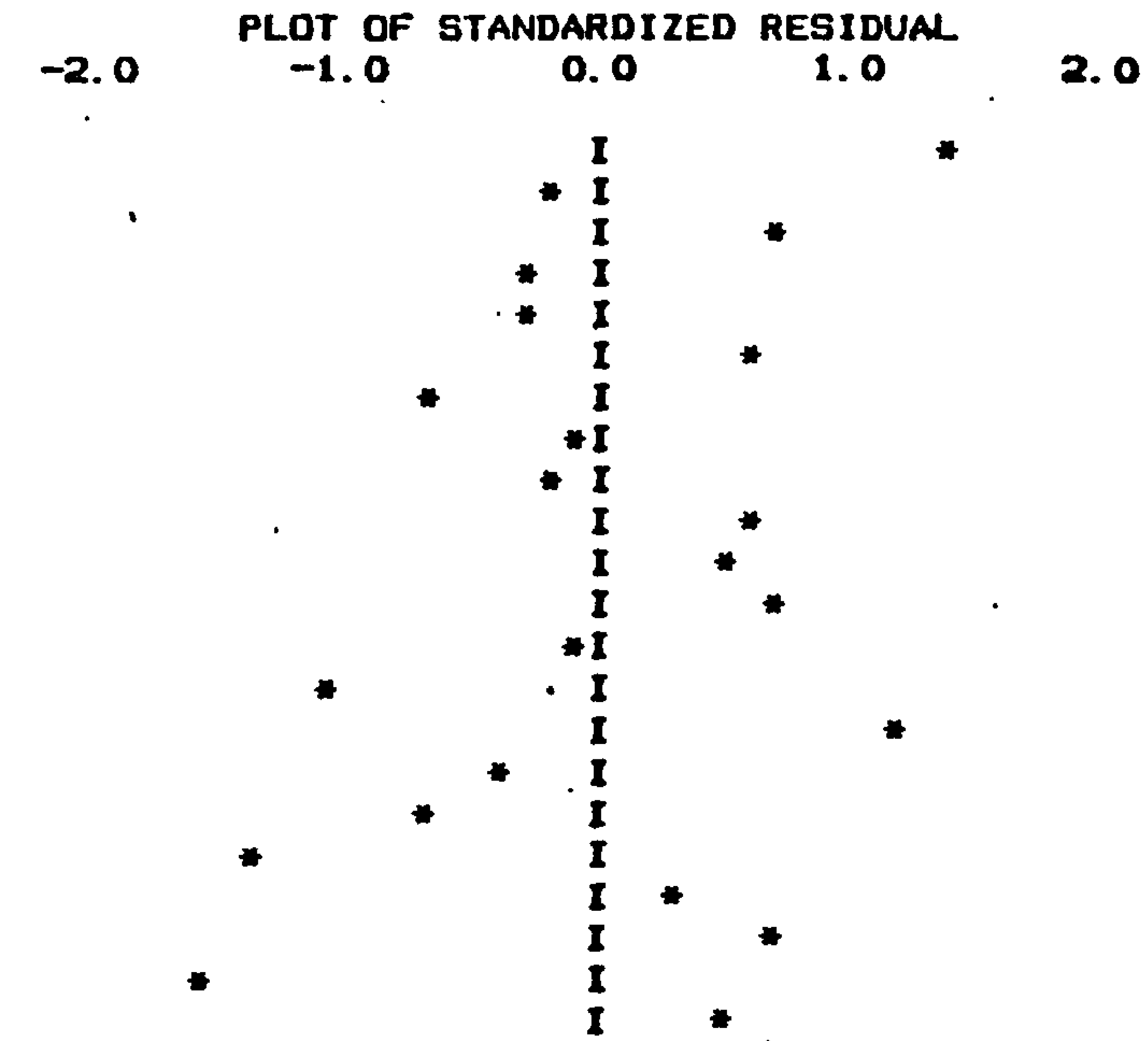
M-1

Area 1 - Multiple Regression Analysis for U with Variables I to R

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * *

DEPENDENT VARIABLE: U FROM VARIABLE LIST 1
REGRESSION LIST 1

SEQNUM	OBSERVED U	PREDICTED U	RESIDUAL
1	65.50000	42.07081	23.42918
2	51.80000	55.94469	-4.144700
3	92.00000	80.11320	11.88678
4	25.50000	31.11779	-5.617791
5	42.50000	47.97678	-5.476780
6	62.10000	51.66380	10.43620
7	35.00000	46.93848	-11.93849
8	42.50000	44.82226	-2.322263
9	25.00000	28.56367	-3.563674
10	56.00000	46.03105	9.968941
11	74.00000	65.26292	8.737066
12	76.00000	63.97992	12.02007
13	57.00000	57.94377	-0.9437729
14	27.00000	44.75305	-17.75306
15	84.00000	64.23508	19.76492
16	55.00000	61.58846	-6.588461
17	44.00000	56.36648	-12.36648
18	46.00000	68.84663	-22.84665
19	64.00000	58.97889	5.021104
20	45.00000	33.64645	11.35354
21	36.75000	63.42768	-26.67769
22	64.00000	56.37801	7.621991



DURBIN-WATSON TEST OF RESIDUAL DIFFERENCES COMPARED BY CASE ORDER (SEQNUM).

VARIABLE LIST 1, REGRESSION LIST 1. DURBIN-WATSON TEST 2.29326

M-2

Area 1 - Plot of standardised residuals and table of observed and predicted U values

FILE F1 (CREATION DATE = 10/06/83)

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * VARIABLE LIST 1
REGRESSION LIST 1

DEPENDENT VARIABLE.. U

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
K	0.82100	0.67404	0.67404	0.82100	12.80670	0.55917
N	0.87354	0.76306	0.08903	-0.69073	-0.2517953	-0.17671
R	0.88006	0.77451	0.01144	-0.46287	-1.197273	-0.21774
Q	0.88451	0.78235	0.00784	0.70957	0.5574716	0.16779
L	0.88740	0.78748	0.00513	0.58111	2.697776	0.06786
O	0.89193	0.79554	0.00805	0.30870	-0.8893153	-0.34719
M	0.89985	0.80974	0.01420	0.38832	6.354717	0.30590
P	(0.66) 0.90093	0.81168	0.00194	-0.58858	0.3330541	0.06855
(CONSTANT)					26.76809	

M-3

Area 2 - Multiple Regression Analysis for U with Variables I to R

```
* * * * * * * * * * * * * * * * * * * * * * *  M U L T I P L E   R E G R E S S I O N  * * * * * * * * * * * * * * *

DEPENDENT VARIABLE:  U          FROM    VARIABLE LIST  1
                                        REGRESSION LIST  1

              OBSERVED          PREDICTED                                        PLOT OF STANDARDIZED RESIDUAL
SEQNUM           U                  U            RESIDUAL         -2.0      -1.0       0.0       1.0       2.0

     1       95.00000          75.18785         19.81214                                  I         *
     2       22.20000          34.27403        -12.07404                         *        I
     3       29.20000          27.91931          1.280679                                 I*
     4       73.00000          70.42160          2.578389                                 I *
     5       24.20000          27.14344         -2.943452                               * I
     6       20.00000          27.91931         -7.919318                            *    I
     7       40.50000          43.20814         -2.708145                               * I
     8       56.00000          34.27403         21.72596                                  I         *
     9       98.25999         107.9179          -9.657938                           *     I
    10       32.00000          58.62397        -26.62398                *                 I
    11       51.00000          46.13788          4.862113                                 I  *
    12       88.84000          90.59552         -1.755534                                *I
    13       51.00000          45.66135          5.338642                                 I  *
    14       51.00000          49.66096          1.339035                                 I*
    15       84.00000          63.92683         20.07317                                  I         *
    16       46.50000          51.80769         -5.307687                              *  I
    17       15.50000          18.63775         -3.137753                               * I
    18       36.00000          37.19427         -1.194273                                *I
    19       77.00000          80.68802         -3.688034                               * I
```

DURBIN-WATSON TEST OF RESIDUAL DIFFERENCES COMPARED BY CASE ORDER (SEQNUM).

VARIABLE LIST 1, REGRESSION LIST 1. DURBIN-WATSON TEST 2.18052

M-4

Area 2 - Plot of standardised residuals and table of observed and predicted U values

FILE F1 (CREATION DATE = 10/06/83)

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * * VARIABLE LIST 1
REGRESSION LIST 1

DEPENDENT VARIABLE.. U

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
G	0.49565	0.24567	0.24567	0.49565	1.343691	0.41223
K	0.57521	0.33087	0.08520	0.47841	10.56799	0.27268
R	0.69470	0.48261	0.15175	-0.10672	4.445939	0.71511
M	0.72134	0.52032	0.03771	0.45654	21.23201	0.78015
O	0.79347	0.62959	0.10926	0.17108	-2.690654	-0.65877
P	0.84187	0.70874	0.07915	-0.43868	-2.981606	-0.54403
I	0.86689	0.75151	0.04277	0.05709	16.60657	0.27755
L	(0.01) 0.86755	0.75265	0.00114	0.08920	-3.179368	-0.04229
(CONSTANT)					-60.33097	

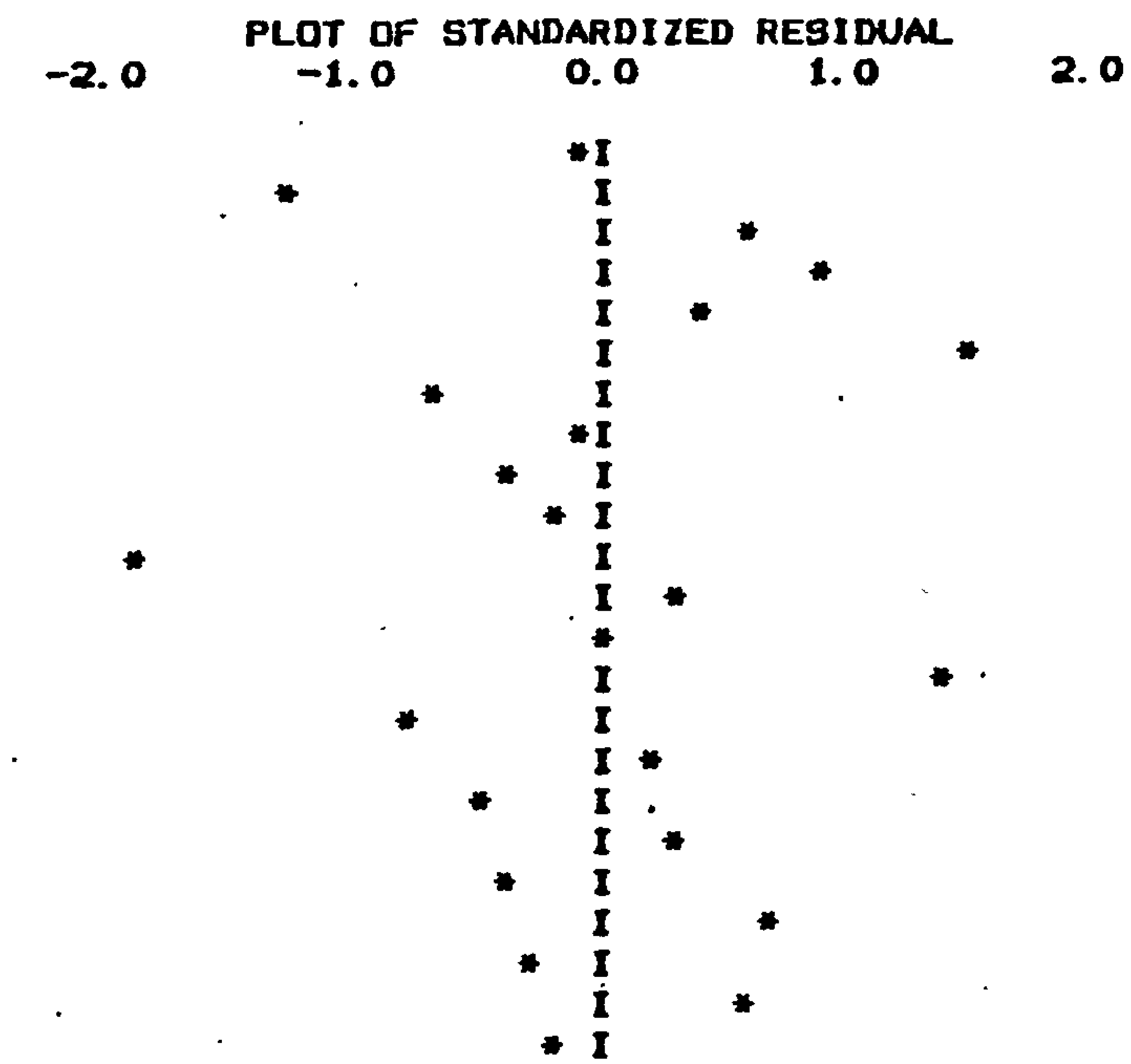
M-5

Area 3 - Multiple Regression Analysis for U with Variables I to R

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * * *

DEPENDENT VARIABLE: U FROM VARIABLE LIST 1
REGRESSION LIST 1

SEQNUM	OBSERVED U	PREDICTED U	RESIDUAL
1	55.00000	57.02057	-2.020574
2	32.00000	55.14252	-23.14253
3	60.00000	48.36849	11.63150
4	42.00000	26.47993	15.52007
5	101.0000	93.50320	7.496778
6	74.00000	46.26452	27.73547
7	10.00000	23.52203	-13.52203
8	38.00000	40.07262	-2.072618
9	17.20000	24.94701	-7.747013
10	20.50000	24.53598	-4.035988
11	29.25000	63.73740	-34.48741
12	48.00000	42.86617	5.133833
13	36.00000	36.90295	-0.9029537
14	53.00000	26.82182	26.17817
15	35.00000	50.09229	-15.09229
16	133.5000	129.2673	4.232690
17	32.50000	40.67883	-8.178835
18	35.00000	29.42926	5.570740
19	56.00000	62.87109	-6.871097
20	93.00000	80.87341	12.12657
21	30.50000	35.67133	-5.171332
22	60.50000	48.95190	11.54809
23	25.50000	29.42926	-3.929260



DURBIN-WATSON TEST OF RESIDUAL DIFFERENCES COMPARED BY CASE ORDER (SEQNUM).

VARIABLE LIST 1. REGRESSION LIST 1. DURBIN-WATSON TEST 2.39058

M-6

Area 3 – Plot of standardised residuals and table of observed and predicted U values

FILE F1 (CREATION DATE = 10/06/83)

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * VARIABLE LIST 1
REGRESSION LIST 1

DEPENDENT VARIABLE.. U

SUMMARY TABLE

VARIABLE		MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
R		0.19936	0.03974	0.03974	-0.19936	-0.6371987	-0.13086
N		0.24132	0.05823	0.01849	-0.12279	-0.9151972	-0.64077
O		0.31425	0.09875	0.04052	-0.08315	-0.7023017	-0.25101
P		0.37706	0.14217	0.04342	0.07157	1.338508	0.30617
M		0.38548	0.14860	0.00642	0.00414	-4.839287	-0.22034
Q		0.39294	0.15440	0.00580	0.19383	0.5329649E-01	0.01610
L		0.39745	0.15796	0.00356	-0.07440	-3.732881	-0.10673
K		0.40788	0.16636	0.00840	0.00744	4.006442	0.24222
I	(-0.29)	0.41384	0.17126	0.00490	-0.09421	-6.386185	-0.12485
(CONSTANT)						111.8819	

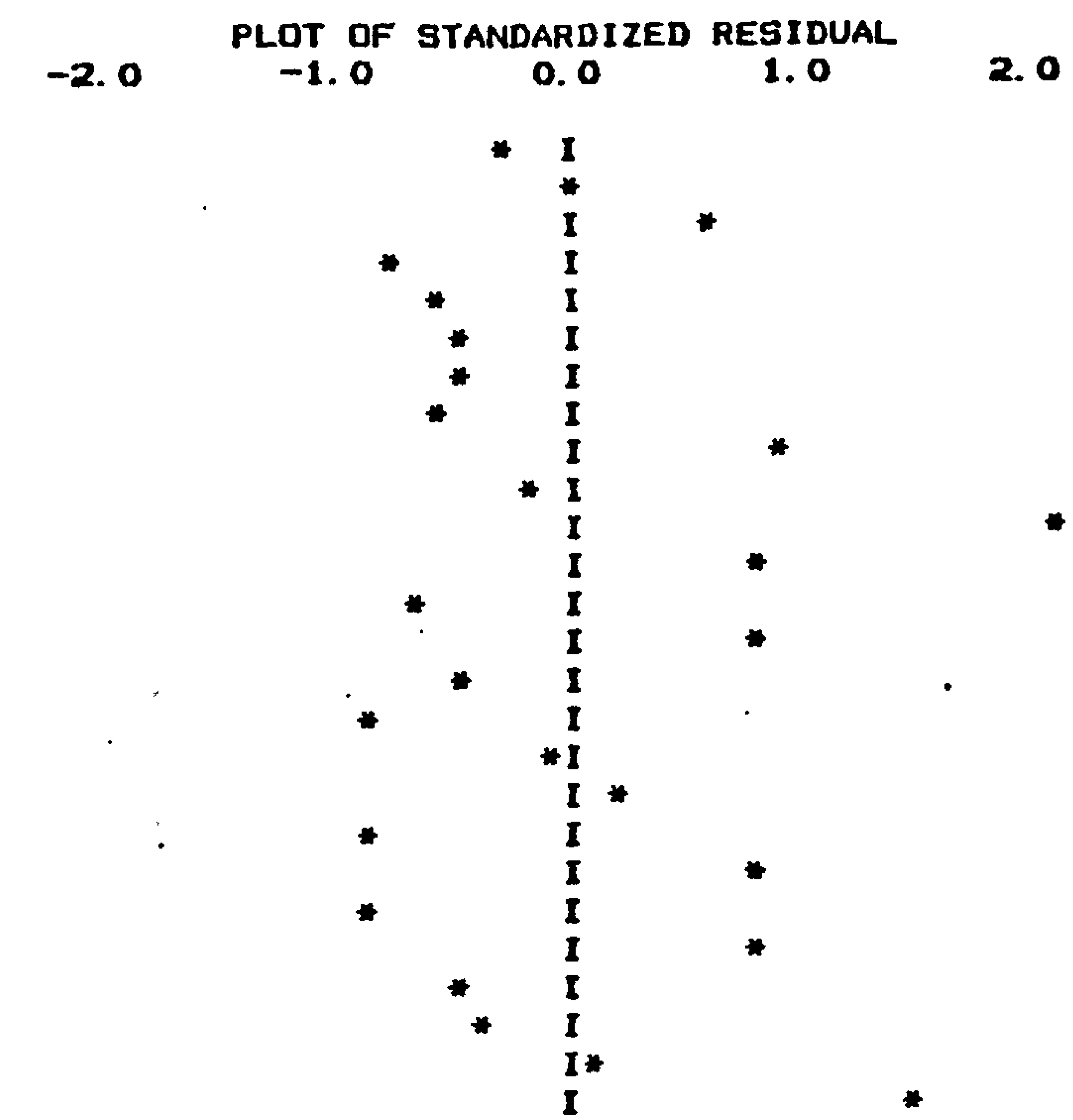
M-7

Area 4 - Multiple Regression Analysis for U with Variables I to R

* M U L T I P L E   R E G R E S S I O N * * * * * * * * * * * * * * * *

DEPENDENT VARIABLE: U   FROM VARIABLE LIST 1
REGRESSION LIST 1

SEQNUM	OBSERVED U	PREDICTED U	RESIDUAL
1	53.50000	61.77913	-8.279133
2	57.00000	56.12728	0.8727115
3	74.00000	57.19986	16.80013
4	44.00000	66.23932	-22.23934
5	34.00000	51.31489	-17.31489
6	40.00000	53.45935	-13.45936
7	26.00000	39.57065	-13.57065
8	44.00000	61.45598	-17.45598
9	86.00000	61.92835	24.07164
10	53.00000	58.44579	-5.445795
11	110.7400	53.72265	57.01733
12	105.0000	83.09485	21.90514
13	45.50000	64.91582	-19.41583
14	76.00000	55.26817	20.73182
15	61.00000	74.02359	-13.02360
16	28.00000	53.70454	-25.70455
17	38.00999	41.15732	-3.147331
18	53.00000	48.17048	4.829515
19	34.00000	58.66963	-24.66964
20	81.50000	60.28035	21.21965
21	27.00000	51.54992	-24.54993
22	78.50000	56.12728	22.37271
23	42.00000	56.12728	-14.12729
24	67.50000	78.39536	-10.89536
25	70.89999	68.61189	2.288094
26	93.64999	52.46008	41.18990



DURBIN-WATSON TEST OF RESIDUAL DIFFERENCES COMPARED BY CASE ORDER (SEQNUM).

VARIABLE LIST 1, REGRESSION LIST 1. DURBIN-WATSON TEST 2.09356

M-8

Area 4 - Plot of standarised residuals and table of observed and predicted U values

FILE F1 (CREATION DATE = 10/06/83)

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * VARIABLE LIST 1
REGRESSION LIST 1

DEPENDENT VARIABLE.. U

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
M	•0. 58629 *	0. 34373	0. 34373	0. 58629	15. 50004	0. 66897
O	•0. 61781 *	0. 38168	0. 03795	0. 34687	-1. 590662	-0. 49806
Q	•0. 65455 *	0. 42844	0. 04676	0. 51255	2. 235834	0. 61451
P	•0. 68387 *	0. 46767	0. 03924	-0. 27506	1. 529252	0. 32624
L	•0. 70087 *	0. 49122	0. 02355	0. 36084	5. 725528	0. 16764
I	(0.34)•0. 70841 *	0. 50184	0. 01062	0. 27316	7. 935912	0. 15491
R	0. 71194	0. 50686	0. 00502	-0. 20032	0. 4312076	0. 09832
N	0. 71221	0. 50724	0. 00038	-0. 41913	0. 8937258E-01	0. 07522
K	0. 71246	0. 50760	0. 00036	0. 27937	0. 9433718	0. 04060
(CONSTANT)					-32. 89156	

M-9

Area 5 - Multiple Regression Analysis for U with Variables I to R

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* * * * * * * * * * * * * * * * * * * * * * * * *   M U L T I P L E   R E G R E S S I O N   * * * * * * * * * * * * * * * .

DEPENDENT VARIABLE:   U          FROM    VARIABLE LIST  1
                                         REGRESSION LIST  1

         OBSERVED    PREDICTED                           PLOT OF STANDARDIZED RESIDUAL
SEGNUM       U            U         RESIDUAL        -2.0      -1.0      0.0       1.0       2.0

     1    119.4000    61.75156    57.64842                              I                     X
     2    55.70000    45.30468    10.39531                              I    *
     3    50.20000    53.77907   -3.579079                            * I
     4    55.80000    50.85809    4.941905                              I *
     5    70.31999    63.36378    6.956209                              I  *
     6    60.00000    71.06395   -11.06396                          *   I
     7    75.96999    82.52121   -6.551241                            * I
     8    40.00000    71.15913   -31.15914                 *            I
     9    92.45000    72.62811    19.82188                              I        *
    10    18.75000    45.73589   -26.98590                   *          I
    11    80.00000    82.30951   -2.309522                             *I
    12    12.00000    23.76774   -11.76775                          *   I
    13    40.00000    36.99388    3.006116                              I*
    14    50.00000    29.20366    20.79633                              I        *
    15    30.00000    31.15250   -1.152508                             *I
    16    44.00000    40.01036    3.989633                              I *
    17    23.00000    29.29248   -6.292486                           *  I
    18    14.00000    24.51033   -10.51033                         *    I
    19    43.35000    44.79252   -1.442525                             *I
    20    34.25000    34.42779  -0.1777956                              *
    21    27.60000    52.72843   -25.12844                   *          I
    22    43.25000    45.73589   -2.485895                             *I
    23    52.50000    37.74739    14.75260                              I      *
    24    39.50000    45.73589   -6.235895                           *  I
    25    30.00000    25.46596    4.534036                              I *

DURBIN-WATSON TEST OF RESIDUAL DIFFERENCES COMPARED BY CASE ORDER (SEQNUM).

VARIABLE LIST  1, REGRESSION LIST  1.     DURBIN-WATSON TEST     1.63666
```

M-10

Area 5 - Plot of standarised residuals and table of observed and predicted U values

FILE F1 (CREATION DATE = 10/06/83)

* M U L T I P L E   R E G R E S S I O N * * * * * * * * * * * * *   VARIABLE LIST 1
REGRESSION LIST 1

DEPENDENT VARIABLE.. U

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
M	0.77012	0.59309	0.59309	0.77012	8.870032	0.53619
O	0.80766	0.65231	0.05922	0.66910	-0.8174227E-01	-0.02363
Q	0.82610	0.68244	0.03013	0.67375	1.213285	0.43780
I	0.83497	0.69717	0.01473	0.13770	-15.58651	-0.26494
K	0.84146	0.70805	0.01088	0.34546	5.545145	0.22105
P	0.84711	0.71760	0.00954	-0.40284	1.788264	0.28020
L	0.85315	0.72787	0.01027	0.27016	5.944829	0.11625
N	0.85491	0.73087	0.00300	-0.55581	-0.2473500	-0.16973
R	(0·51) 0.85572	0.73225	0.00139	-0.24821	0.2346392	0.05069
(CONSTANT)					-11.13048	

M-11

Area 6 - Multiple Regression Analysis for U with Variables I to R

```
* * * * * * * * * * * * * * * * * * * * * * * *  M U L T I P L E   R E G R E S S I O N  * * * * * * * * * * * * * * * *

DEPENDENT VARIABLE:  U          FROM    VARIABLE LIST  1
                                      REGRESSION LIST  1

             OBSERVED          PREDICTED                                   PLOT OF STANDARDIZED RESIDUAL
SEQNUM          U                  U             RESIDUAL          -2.0      -1.0      0.0      1.0      2.0

    1        68.50000          76.13237        -7.632384                           *    I
    2        63.50000          65.24986        -1.749868                               *I
    3        15.82000          25.36769        -9.547701                          *     I
    4        64.00000          66.27454        -2.274551                               *I
    5        34.00000          40.13905        -6.139051                             *  I
    6        63.25000          75.08345       -11.83346                          *      I
    7        36.50000          36.69299        -0.1930019                               *
    8        68.00000          65.13634         2.863652                                I *
    9       121.0000           93.42471        27.57528                                 I              *
   10        77.00000          73.63498         3.365010                                I *
   11        69.20000          55.63689        13.56310                                 I       *
   12        76.20000          74.42078         1.779215                                I*
   13        63.50000          75.79912       -12.29912                          *      I
   14        71.50000          67.64017         3.859829                                I *
   15        97.00000         106.7971         -9.797123                          *      I
   16        88.23999          98.63518       -10.39520                           *      I
   17        74.00000          74.48991        -0.4899298                               *
   18        74.00000          69.92828         4.071707                                I *
   19        85.00000          72.73112        12.26887                                 I      *
   20        66.50000          40.95419        25.54579                                 I             *
   21        26.76000          49.30107       -22.54108                    *              I


DURBIN-WATSON TEST OF RESIDUAL DIFFERENCES COMPARED BY CASE ORDER (SEQNUM).

VARIABLE LIST  1. REGRESSION LIST  1.    DURBIN-WATSON TEST    1.69998
```

M-12

Area 6 - Plot of standardised residuals and table of observed and predited U values

FILE F1 (CREATION DATE = 10/06/83)

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * VARIABLE LIST 1
REGRESSION LIST 1

DEPENDENT VARIABLE.. U

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
K	0.59370	0.35248	0.35248	0.59370	15.87358	0.76979
M	0.67138	0.45075	0.09826	0.53191	10.20175	0.42431
P	0.72450	0.52490	0.07416	-0.13173	2.201491	0.38314
Q	0.75592	0.57141	0.04651	0.14909	-1.048338	-0.28184
N	0.78541	0.61687	0.04546	-0.17344	-0.8692208	-0.35875
O	0.81277	0.66059	0.04372	0.41138	-1.097790	-0.32779
I	0.83676	0.70017	0.03958	0.54245	16.61604	0.28828
R	(0.59) 0.84681	0.71709	0.01692	0.26142	1.007393	0.16490
(CONSTANT)					-14.16232	

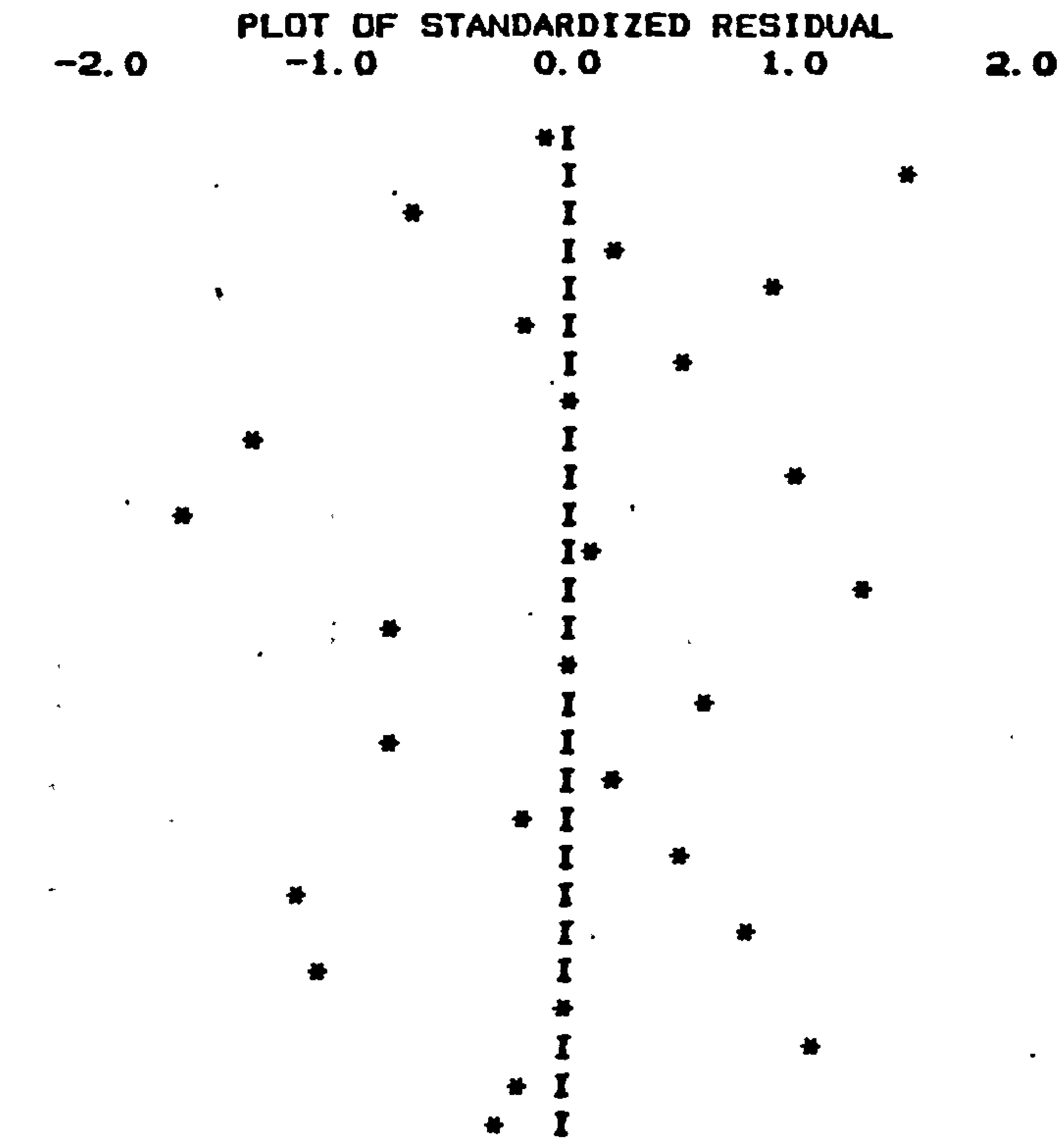
M-13

Area 7 - Multiple Regression Analysis for U with Variables I to R

* M U L T I P L E   R E G R E S S I O N * * * * * * * * * * * * * * *

DEPENDENT VARIABLE: U FROM VARIABLE LIST 1
REGRESSION LIST 1

SEQNUM	OBSERVED U	PREDICTED U	RESIDUAL
1	82.00000	84.19609	-2.196097
2	129.5000	100.4297	29.07025
3	37.39999	49.63560	-12.23561
4	49.00000	45.28831	3.711682
5	30.50000	14.50111	15.99889
6	15.00000	19.21299	-4.212989
7	45.00000	35.50343	9.496567
8	34.00000	34.16933	-0.1693325
9	37.50000	63.39991	-25.89992
10	35.00000	16.82772	18.17227
11	49.25000	81.71703	-32.46704
12	61.00000	59.35204	1.647950
13	120.0000	95.23239	24.76760
14	30.25000	45.51499	-15.26500
15	54.00000	54.51634	-0.5163474
16	90.00000	78.88522	11.11477
17	24.00000	38.73769	-14.73770
18	75.00000	71.78242	3.217559
19	54.50000	57.96758	-3.467591
20	44.50000	35.50343	8.996567
21	33.00000	54.61127	-21.61127
22	101.5000	86.57190	14.92809
23	27.00000	47.99812	-20.99812
24	71.25000	70.42868	0.8213112
25	34.30000	13.49372	20.80627
26	41.00000	43.88824	-2.888245
27	75.00000	81.08455	-6.084560



DURBIN-WATSON TEST OF RESIDUAL DIFFERENCES COMPARED BY CASE ORDER (SEQNUM).

VARIABLE LIST 1, REGRESSION LIST 1. DURBIN-WATSON TEST 2.96763

M-14

Area 7 - Plot of standardised residuals and table of observed and predicted U Values

FILE F1 (CREATION DATE = 10/06/83)

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * VARIABLE LIST 1
REGRESSION LIST 1

DEPENDENT VARIABLE.. U

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
M	0.59736	0.35684	0.35684	0.59736	13.29401	0.52184
I	0.66365	0.44044	0.08359	-0.28375	-20.87927	-0.26465
R	0.71131	0.50596	0.06552	0.07426	1.735314	0.26634
N	0.72485	0.52541	0.01945	-0.50285	-0.6816228	-0.29173
Q	0.72641	0.52767	0.00226	0.36665	-0.1990442	-0.08029
O	0.72767	0.52951	0.00184	0.42160	0.2321277	0.06193
L	(0.55) 0.72854	0.53077	0.00126	0.32140	3.945627	0.07409
P	0.72911	0.53160	0.00083	-0.21981	0.3517223	0.04675
K	0.72968	0.53243	0.00083	0.41646	-1.605573	-0.07462
(CONSTANT)					45.04394	

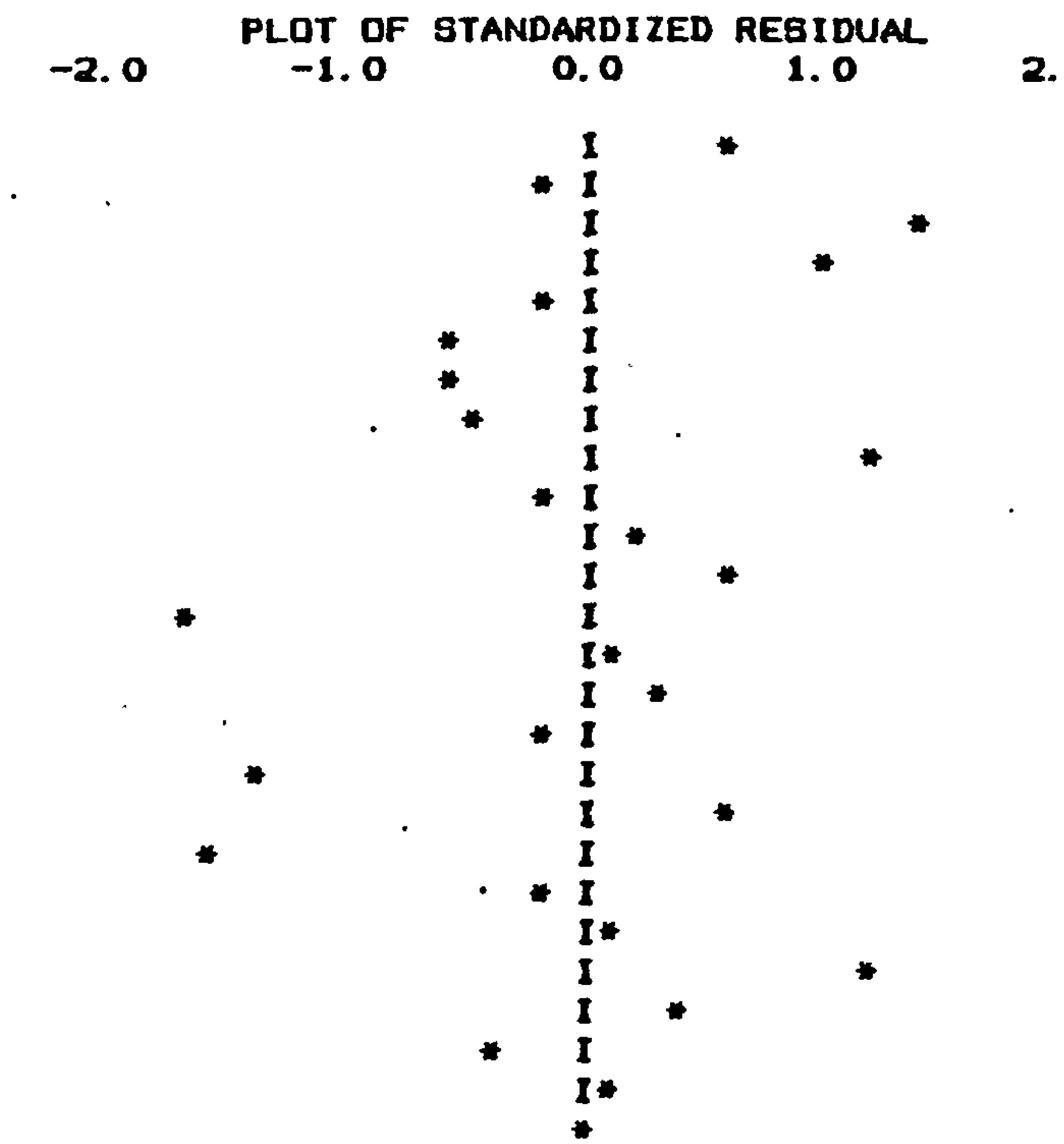
M-15

Area 8 - Multiple Regression Analysis for U with Variables I to R

* M U L T I P L E   R E G R E S S I O N * * * * * * * * * * * * * *

DEPENDENT VARIABLE: U   FROM   VARIABLE LIST 1
REGRESSION LIST 1

SEQNUM	OBSERVED U	PREDICTED U	RESIDUAL
1	113.0000	93.56509	19.43490
2	40.00000	44.93412	-4.934130
3	185.5000	140.1519	45.34802
4	131.5000	99.81781	31.68217
5	86.00000	92.37970	-6.379710
6	29.30000	47.42355	-18.12356
7	72.25000	91.73094	-19.48095
8	52.25000	68.96040	-16.71041
9	78.00000	40.98849	37.01150
10	58.00000	65.81340	-7.813405
11	64.00000	57.16921	6.830782
12	69.00000	51.28091	17.71908
13	15.00000	69.09885	-54.09885
14	46.00000	42.59407	3.405924
15	44.00000	34.63326	9.366739
16	64.00000	71.07341	-7.073424
17	40.00000	84.85669	-44.85670
18	48.00000	29.97187	18.02812
19	40.50000	90.79581	-50.29581
20	44.50000	49.68671	-5.186712
21	67.75000	65.77278	1.977206
22	83.50000	44.50004	38.99995
23	116.5000	103.1892	13.31079
24	31.75000	44.05154	-12.30155
25	32.00000	28.44321	3.556783
26	60.50000	59.91677	0.5832266



DURBIN-WATSON TEST OF RESIDUAL DIFFERENCES COMPARED BY CASE ORDER (SEQNUM).

VARIABLE LIST 1. REGRESSION LIST 1.   DURBIN-WATSON TEST   2.10866

M-16

Area 8 - Plot of standardised residuals and table of observed and predicted U values

FILE F1 (CREATION DATE = 10/06/83)

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * VARIABLE LIST 1

REGRESSION LIST 1

DEPENDENT VARIABLE.. U

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
M	0.69024	0.47643	0.47643	0.69024	13.62925	0.62586
R	0.71284	0.50814	0.03170	-0.42305	-0.4335341	-0.09225
O	0.72633	0.52755	0.01941	0.61073	0.8698015	0.33062
L	0.73965	0.54708	0.01953	0.18947	-7.472199	-0.23049
Q	0.74629	0.55695	0.00987	0.50899	-0.5497091	-0.24298
K	0.75501	0.57003	0.01309	0.44621	1.771273	0.11391
I	0.75542	0.57066	0.00062	0.46929	2.101251	0.04310
P	0.75619	0.57183	0.00117	-0.42609	-0.3921056	-0.08690
N	(c.35) 0.75662	0.57247	0.00065	-0.63781	0.8774644E-01	0.06461
(CONSTANT)					16.00701	

M-17

Area 9 - Multiple Regression Analysis for U with Variables I to R

* M U L T I P L E   R E G R E S S I O N * * * * * * * * * * * * * * * * *

DEPENDENT VARIABLE: U   FROM VARIABLE LIST 1
REGRESSION LIST 1

SEQNUM	OBSERVED U	PREDICTED U	RESIDUAL	PLOT OF STANDARDIZED RESIDUAL -2.0 -1.0 0.0 1.0 2.0
1	47.50000	30.05406	17.44594	I *
2	62.00000	44.55611	17.44388	I *
3	61.50000	51.40986	10.09013	I *
4	18.00000	23.62917	-5.629172	* I
5	29.00000	17.37944	11.62055	I *
6	62.50000	64.33539	-1.835404	*I
7	109.0000	76.18100	32.81898	I *
8	65.00000	58.85691	6.143081	I *
9	75.00000	60.43896	14.56103	I *
10	51.75999	68.53293	-16.77295	* I
11	51.00000	52.44869	-1.448698	*I
12	85.00000	81.19855	3.801451	I *
13	29.75000	33.52662	-3.776625	* I
14	58.00000	74.19220	-16.19221	* I
15	22.75000	33.10995	-10.35996	* I
16	61.50000	74.20139	-12.70140	* I
17	40.25000	47.18930	-6.939303	* I
18	22.25000	23.53650	-1.286508	*I
19	78.00000	49.49839	28.50161	I *
20	18.50000	37.46127	-18.96128	* I
21	14.00000	29.23743	-15.23743	* I
22	29.60000	66.89687	-37.29688	* I
23	38.00000	56.86918	-18.86919	* I
24	52.00000	47.09718	4.902810	I *
25	93.00000	74.57951	18.42048	I *
26	47.75000	45.08301	2.666986	I*
27	32.00000	33.10995	-1.109957	*I

DURBIN-WATSON TEST OF RESIDUAL DIFFERENCES COMPARED BY CASE ORDER (SEQNUM).

VARIABLE LIST 1, REGRESSION LIST 1.   DURBIN-WATSON TEST   1.40630

Area 9 - Plot of standardised residuals and table of observed and predicted U Values

FILE F1 (CREATION DATE = 10/06/83)

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * VARIABLE LIST 1
REGRESSION LIST 1

DEPENDENT VARIABLE.. U

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
M	•0.59506	0.35410	0.35410	0.59506	6.278367	0.35034
G	•0.66904	0.44761	0.09351	0.50960	1.098461	0.33745
O	•0.69251	0.47956	0.03196	0.57685	1.120293	0.27645
I	•0.70237	0.49332	0.01376	0.17587	-8.101302	-0.11628
R	•0.70615	0.49864	0.00532	-0.24230	-0.6446634	-0.09933
N	(0.35)•0.70842	0.50186	0.00322	-0.45882	0.1605882	0.09081
(CONSTANT)					20.62194	

M-19

Area 10 - Multiple Regression Analysis for U with Variables I to R

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* * * * * * * * * * * * * * * * * * * * * * * * *  M U L T I P L E   R E G R E S S I O N  * * * * * * * * * * * * * * * *

DEPENDENT VARIABLE:   U            FROM    VARIABLE LIST  1
                                         REGRESSION LIST  1

         OBSERVED      PREDICTED                                      PLOT OF STANDARDIZED RESIDUAL
SEQNUM      U             U          RESIDUAL                -2.0      -1.0      0.0       1.0       2.0

    1    160.5000      95.53409      64.96590                                I                     X
    2    59.00000      85.51945     -26.51946                       *        I
    3    101.0000      78.33899      22.66099                                I       *
    4    91.00000      67.54106      23.45893                                I       *
    5    44.00000      90.07512     -46.07513                *               I
    6    61.25000      73.07315     -11.82316                           *    I
    7    54.00000      42.48586      11.51414                                I   *
    8    40.25999      79.37120     -39.11122                  *             I
    9    36.00000      68.44125     -32.44127                    *           I
   10    45.39999      50.26790     -4.867912                           *  I
   11    124.0000      131.3424     -7.342390                            * I
   12    120.0000      106.5106      13.48941                                I    *
   13    35.80000      37.10549     -1.305501                                *
   14    27.75000      55.13403     -27.38403                      *         I
   15    74.50000      52.17155      22.32845                                I       *
   16    17.00000      26.53754     -9.537540                            *  I
   17    55.00000      41.55228      13.44772                                I    *
   18    28.20000      55.73946     -27.53946                      *         I
   19    72.00000      67.21991      4.780083                                I *
   20    86.70000      66.19992      20.50007                                I      *
   21    55.00000      59.75329     -4.753289                              * I
   22    32.50000      50.57029     -18.07029                          *     I
   23    42.00000      32.81590      9.184092                                I  *
   24    53.00000      32.81590      20.18409                                I      *
   25    75.00000      67.94730      7.052692                                I  *
   26    105.0000      75.33002      29.66997                                I          *
   27    26.35000      32.81590     -6.465909                              * I


DURBIN-WATSON TEST OF RESIDUAL DIFFERENCES COMPARED BY CASE ORDER (SEQNUM).

VARIABLE LIST   1. REGRESSION LIST  1.     DURBIN-WATSON TEST     2.07500
```


Area 10 - Plot of standardised residuals and table of observed and predicted U values

FILE F1 (CREATION DATE = 10/06/83)

* M U L T I P L E   R E G R E S S I O N * * * * * * * * * * * * * * VARIABLE LIST 1
REGRESSION LIST 1

DEPENDENT VARIABLE.. U

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
Q	0.76723	0.58864	0.58864	0.76723	4.581838	1.29109
R	0.88146	0.77697	0.18833	-0.13595	5.838750	0.64035
P	0.93523	0.87465	0.09767	-0.71724	-2.013790	-0.38944
O	0.94711	0.89701	0.02236	0.39650	-0.4200932	-0.09531
K	0.95227	0.90682	0.00981	0.70989	0.8151237	0.03747
L	0.95519	0.91238	0.00556	0.73799	-13.23523	-0.36238
I	0.95566	0.91329	0.00091	0.30944	-4.668842	-0.04109
M	0.95590	0.91375	0.00045	0.70290	2.790170	0.10893
N	(0.79) 0.95654	0.91497	0.00122	-0.47445	0.2342089	0.11188
(CONSTANT)					-44.96823	

M-21

Area 11 - Multiple Regression Analysis for U with Variables I to R

```
* * * * * * * * * * * * * * * * * * * * * * *  M U L T I P L E   R E G R E S S I O N  * * * * * * * * * * * * * *

DEPENDENT VARIABLE:  U         FROM    VARIABLE LIST  1
                                     REGRESSION LIST  1

           OBSERVED         PREDICTED                                      PLOT OF STANDARDIZED RESIDUAL
SEGNUM        U                 U          RESIDUAL             -2.0        -1.0        0.0        1.0        2.0

    1      148.0000         134.0297       13.97025                                      I      *
    2      16.00000         35.10491      -19.10492                           *          I
    3      35.00000         35.03925      -0.3925240E-01                                 *
    4      145.0000         146.6411      -1.641122                                     *I
    5      85.00000         88.34123      -3.341238                                    * I
    6      57.00000         37.89508       19.10491                                      I         *
    7      51.75000         44.38709       7.362901                                      I   *
    8      81.29999         79.41959       1.880387                                      I*
    9      37.50000         34.27844       3.221554                                      I *
   10      43.00000         43.88325      -0.8832506                                     *
   11      76.00000         95.93361      -19.93362                           *          I
   12      17.50000         30.43607      -12.93607                               *      I
   13      94.75000         84.26230       10.48769                                      I    *
   14      70.64999         76.46442      -5.814435                                   *  I
   15      75.78999         81.31796      -5.527971                                   *  I
   16      42.00000         28.80582       13.19417                                      I      *

DURBIN-WATSON TEST OF RESIDUAL DIFFERENCES COMPARED BY CASE ORDER (SEGNUM).

VARIABLE LIST  1. REGRESSION LIST  1.    DURBIN-WATSON TEST    1.94176
```


Area 11 - Plot of standardised residuals and table of observed and predicted U values

FILE F1 (CREATION DATE = 10/06/83)

* M U L T I P L E   R E G R E S S I O N * * * * * * * * * * * * * VARIABLE LIST 1
REGRESSION LIST 1

DEPENDENT VARIABLE.. U

SUMMARY TABLE

VARIABLE		MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
M	(0.17)	0.46719	0.21826	0.21826	0.46719	7.803165	0.32286
Q		0.49078	0.24086	0.02260	0.17972	1.450742	0.35924
R		0.51850	0.26884	0.02798	0.27327	2.547094	0.39990
I		0.53702	0.28839	0.01954	0.16696	11.20961	0.15835
L		0.55760	0.31092	0.02253	0.17872	-17.65376	-0.28360
P		0.56782	0.32242	0.01151	-0.25181	-1.088952	-0.14465
N		0.57265	0.32793	0.00551	-0.19517	0.1750993	0.07311
O		0.57517	0.33082	0.00289	0.29121	0.2250729	0.06662
K		0.57647	0.33231	0.00150	0.19379	-1.392120	-0.04992
(CONSTANT)						22.27718	

M-23

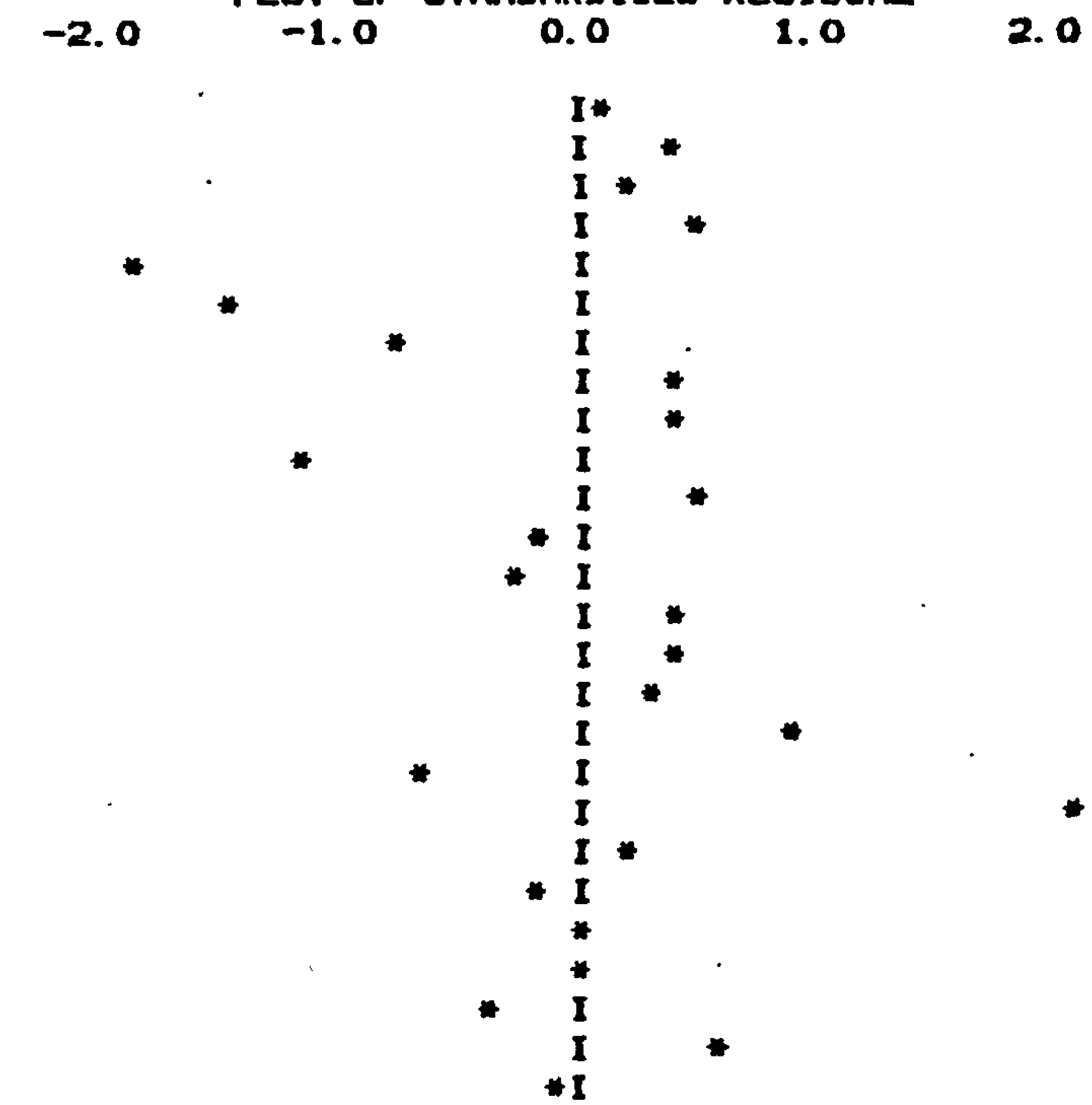
Area 12 - Multiple Regression Analysis for U with Variables I to R

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * *

DEPENDENT VARIABLE: U FROM VARIABLE LIST 1
REGRESSION LIST 1

SEQNUM	OBSERVED U	PREDICTED U	RESIDUAL
1	43.00000	39.97279	3.027201
2	59.50000	47.84854	11.65145
3	92.34999	84.95316	7.396828
4	91.75000	75.57062	16.17937
5	20.00000	83.03868	-63.03870
6	30.74000	81.11823	-50.37823
7	43.00000	70.59669	-27.59671
8	97.00000	82.37343	14.62657
9	85.00000	72.57904	12.42096
10	71.50000	109.5367	-38.03672
11	122.7300	107.0547	15.67529
12	77.00000	83.88849	-6.888491
13	69.00000	77.19702	-8.197029
14	79.75000	67.24919	12.50080
15	98.25000	86.28415	11.96585
16	75.00000	66.15132	8.848667
17	86.00000	55.80475	30.19525
18	29.50000	53.42725	-23.92726
19	169.5600	101.5896	67.97037
20	102.0000	93.82359	8.176394
21	75.50000	81.89874	-6.398746
22	68.00000	67.99562	0.4373915E-02
23	48.00000	48.32998	-0.3299831
24	40.00000	52.83816	-12.83816
25	80.00000	59.12089	20.87910
26	53.00000	56.88848	-3.888484

PLOT OF STANDARDIZED RESIDUAL



DURBIN-WATSON TEST OF RESIDUAL DIFFERENCES COMPARED BY CASE ORDER (SEQNUM).

VARIABLE LIST 1, REGRESSION LIST 1. DURBIN-WATSON TEST 1.91973

M-24

Area 12 - Plot of standardised residuals and table of observed and predicted U values

FILE F1 (CREATION DATE = 10/06/83)

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * VARIABLE LIST 1
REGRESSION LIST 1

DEPENDENT VARIABLE.. U

SUMMARY TABLE

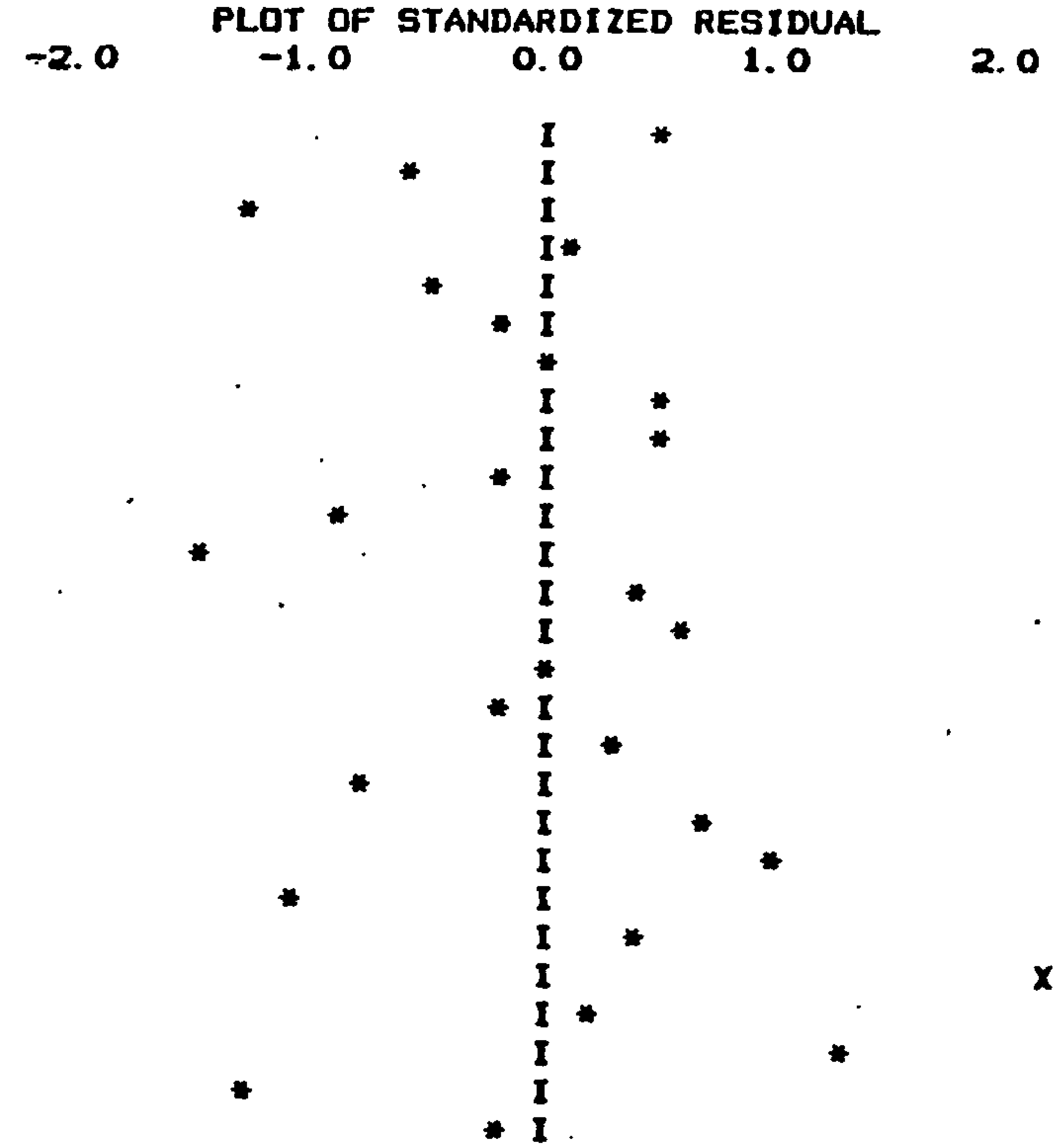
VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
M	0.43803	0.19187	0.19187	0.43803	4.735652	0.35186
L	0.52628	0.27697	0.08511	-0.13167	-22.11247	-0.64969
Q	0.59261	0.35118	0.07421	0.29876	1.760215	0.75291
R	0.73758	0.54403	0.19285	0.07869	1.750710	0.53527
I	0.74323	0.55238	0.00835	0.22662	4.121238	0.08631
O	0.74632	0.55700	0.00461	0.40057	0.2064893	0.09015
P	(0.39) 0.74672	0.55759	0.00060	-0.14053	0.1432788	0.03419
(CONSTANT)					25.54179	

Area 13 - Multiple Regression Analysis for U with Variables I to R

* M U L T I P L E   R E G R E S S I O N * * * * * * * * * * * * * *

DEPENDENT VARIABLE: U FROM VARIABLE LIST 1
REGRESSION LIST 1

SEQNUM	OBSERVED U	PREDICTED U	RESIDUAL
1	65.84000	57.66299	8.177000
2	62.00000	71.25194	-9.251949
3	46.00000	66.59303	-20.59304
4	48.39999	47.08807	1.311922
5	38.20000	46.84913	-8.649137
6	73.00000	75.59219	-2.592195
7	24.00000	24.73666	-0.7366668
8	55.00000	47.57629	7.423705
9	54.00000	46.08451	7.915483
10	35.00000	37.96530	-2.965306
11	46.00000	60.11731	-14.11731
12	35.95000	60.27135	-24.32136
13	47.25999	40.47987	6.780113
14	55.00000	45.79795	9.202040
15	58.50000	57.88246	0.6175312
16	44.25000	46.84913	-2.599134
17	89.50000	84.31760	5.182390
18	45.95999	58.01683	-12.05684
19	81.00000	70.25560	10.74439
20	70.00000	54.49277	15.50722
21	20.30000	38.34026	-18.04026
22	52.89999	46.84913	6.050859
23	104.6000	69.17441	35.42558
24	76.64999	73.13972	3.510265
25	74.50000	53.83880	20.66120
26	45.00000	65.02151	-20.02153
27	87.50000	90.06496	-2.564970



DURBIN-WATSON TEST OF RESIDUAL DIFFERENCES COMPARED BY CASE ORDER (SEQNUM).

VARIABLE LIST 1, REGRESSION LIST 1. DURBIN-WATSON TEST 1.96801

Area 13 – Plot of standardised residuals and table of observed and predicted U values

FILE F1 (CREATION DATE = 10/06/83)

* M U L T I P L E   R E G R E S S I O N * * * * * * * * * * * * * *   VARIABLE LIST 1
REGRESSION LIST 1

DEPENDENT VARIABLE.. U

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
O	0.56885	0.32359	0.32359	0.56885	1.168498	0.34890
Q	0.65162	0.42461	0.10102	0.02408	-1.389257	-0.37430
K	0.72675	0.52817	0.10355	0.44145	8.487643	0.56189
P	0.75035	0.56302	0.03486	-0.04933	2.271701	0.55785
L	0.77406	0.59917	0.03615	0.46809	11.92018	0.34997
N	0.78774	0.62053	0.02136	-0.42524	-0.9686611	-0.58025
M	0.80897	0.65444	0.03391	0.40648	-10.02115	-0.45845
I	0.81461	0.66358	0.00915	0.26678	10.05642	0.10745
R	(0.47) 0.81477	0.66385	0.00027	-0.03649	-0.1848914	-0.02698
(CONSTANT)					60.29631	

M-27

Area 14 - Multiple Regression Analysis for U with Variables I to R

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* * * * * * * * * * * * * * * * * * * * * * * *   M U L T I P L E   R E G R E S S I O N   * * * * * * * * * * * * * *

DEPENDENT VARIABLE:   U          FROM    VARIABLE LIST  1
                                      REGRESSION LIST  1

         OBSERVED            PREDICTED                     PLOT OF STANDARDIZED RESIDUAL
SEGNUM      U                    U     RESIDUAL     -2.0      -1.0      0.0       1.0       2.0

   1       65.25000      74.48892     -9.238937                      *   I
   2       105.9900      109.0675     -3.077537                         *I
   3       63.50000      63.66577    -0.1657745                          *
   4       84.00000      80.32414      3.675842                          I *
   5       84.50000      87.23175     -2.731762                         *I
   6       66.00000      68.48140     -2.481402                         *I
   7       81.50000      73.82999      7.669999                          I  *
   8       56.25000      76.84126     -20.59127                  *       I
   9       81.50000      77.07628      4.423717                          I *
  10       39.50000      60.63556     -21.13557                 *        I
  11       151.0000      137.0168      13.98321                          I     *
  12       56.39999      54.42304      1.976946                          I*
  13       65.75000      40.90507      24.84493                          I          *
  14       72.09999      45.12170      26.97828                          I           *
  15       53.24000      24.72210      28.51789                          I            *
  16       44.00000      65.19928     -21.19929                 *        I
  17       74.00000      77.22702     -3.227030                         *I
  18       17.70000      46.65521     -28.95523             *            I
  19       61.25000      46.69048      14.55951                          I      *
  20       106.1200      102.6641      3.455892                          I *
  21       29.00000      54.57995     -25.57996              *           I
  22       46.00000      61.08503     -15.08503                   *      I
  23       22.30000      46.69048     -24.39050               *          I
  24       111.5000      99.66020      11.83980                          I    *
  25       102.5000      101.8675     0.6325328                          *
  26       100.5000      65.19928      35.30071                          I               *


DURBIN-WATSON TEST OF RESIDUAL DIFFERENCES COMPARED BY CASE ORDER (SEGNUM).

VARIABLE LIST   1. REGRESSION LIST  1.     DURBIN-WATSON TEST     1.70757
```

M-28

Area 14 - Plot of standardised residuals and table of observed and predicted U values

FILE F1 (CREATION DATE = 10/06/83)

* M U L T I P L E   R E G R E S S I O N * * * * * * * * * * * * *   VARIABLE LIST 1
REGRESSION LIST 1

DEPENDENT VARIABLE.. U

SUMMARY TABLE

VARIABLE		MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
M		0.61831	0.38230	0.38230	0.61831	8.352826	0.35120
L		0.62959	0.39638	0.01408	-0.20828	-5.332295	-0.11869
O		0.63963	0.40913	0.01275	0.56053	0.8043146	0.30491
I		0.65420	0.42798	0.01884	0.05295	5.124125	0.11048
K		0.66002	0.43563	0.00766	0.45146	4.442590	0.17057
Q	(0·28)	0.66699	0.44487	0.00924	0.20845	-0.5336378	-0.17218
R		0.67011	0.44904	0.00417	-0.15855	-0.3983694	-0.09872
P		0.67147	0.45087	0.00182	-0.34399	0.2757154	0.07131
(CONSTANT)						25.48456	

M-29

Area 15 - Multiple Regression Analysis for U with Variables I to R

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* * * * * * * * * * * * * * * * * * * * * * *  M U L T I P L E   R E G R E S S I O N  * * * * * * * * * * * * * * *

DEPENDENT VARIABLE:  U          FROM    VARIABLE LIST  1
                                      REGRESSION LIST  1

            OBSERVED          PREDICTED                               PLOT OF STANDARDIZED RESIDUAL
SEQNUM         U                  U            RESIDUAL          -2.0      -1.0      0.0       1.0       2.0

     1      84.29999          61.72737         22.57261                              I           *
     2      73.50000          67.58917         5.910823                              I  *
     3      78.64999          63.89641         14.75358                              I       *
     4      91.00000          77.31627         13.68373                              I      *
     5      47.75999          55.75111        -7.991124                          *   I
     6      44.50000          35.23953         9.260462                              I    *
     7      40.50000          38.81702         1.682979                              I*
     8      28.00000          33.54176        -5.541762                           *  I
     9      92.00000          70.17984         21.82016                              I          *
    10      101.5000          73.87881         27.62117                              I             *
    11      39.50000          43.25961        -3.759612                            * I
    12      48.25000          74.52797        -26.27798                *             I
    13      43.50000          41.29293         2.207062                              I*
    14      43.95000          61.59206        -17.64207                     *        I
    15      38.50000          61.39471        -22.89472                  *           I
    16      31.50000          48.38373        -16.88374                     *        I
    17      88.00000          59.50335         28.49664                              I              *
    18      73.25000          84.08949        -10.83951                        *     I
    19      38.50000          55.75111        -17.25112                     *        I
    20      75.00000          72.71339         2.286591                              I*
    21      50.00000          48.38373         1.616264                              I*
    22      65.75000          57.52902         8.220974                              I   *
    23      60.00000          61.17915        -1.179152                             *I
    24      43.50000          43.25961        0.2403886                              *
    25      37.00000          38.59924        -1.599246                             *I
    26      42.50000          37.58495         4.915040                              I  *
    27      38.00000          71.42845        -33.42847             *                I

DURBIN-WATSON TEST OF RESIDUAL DIFFERENCES COMPARED BY CASE ORDER (SEQNUM).

VARIABLE LIST  1, REGRESSION LIST  1.     DURBIN-WATSON TEST     1.57257
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Area 15 - Plot of standardised residuals and table of observed and predicted U values

FILE F1 (CREATION DATE = 10/06/83)

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * VARIABLE LIST 1
REGRESSION LIST 1

DEPENDENT VARIABLE.. U

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
M	0.52323	0.27377	0.27377	0.52323	7.798808	0.36717
K	0.56649	0.32091	0.04714	0.40748	4.151898	0.22148
I	0.56905	0.32381	0.00290	0.21069	3.582029	0.06232
Q	0.57035	0.32530	0.00148	0.36065	0.2408157	0.07864
R	0.57289	0.32820	0.00291	-0.05650	0.3698377	0.06777
N	0.57478	0.33037	0.00216	-0.37830	-0.1612343	-0.10348
P	0.57698	0.33291	0.00254	-0.26928	0.3804473	0.07520
O	(0.32) 0.57707	0.33301	0.00010	0.39503	-0.4792525E-01	-0.01496
(CONSTANT)					16.38102	

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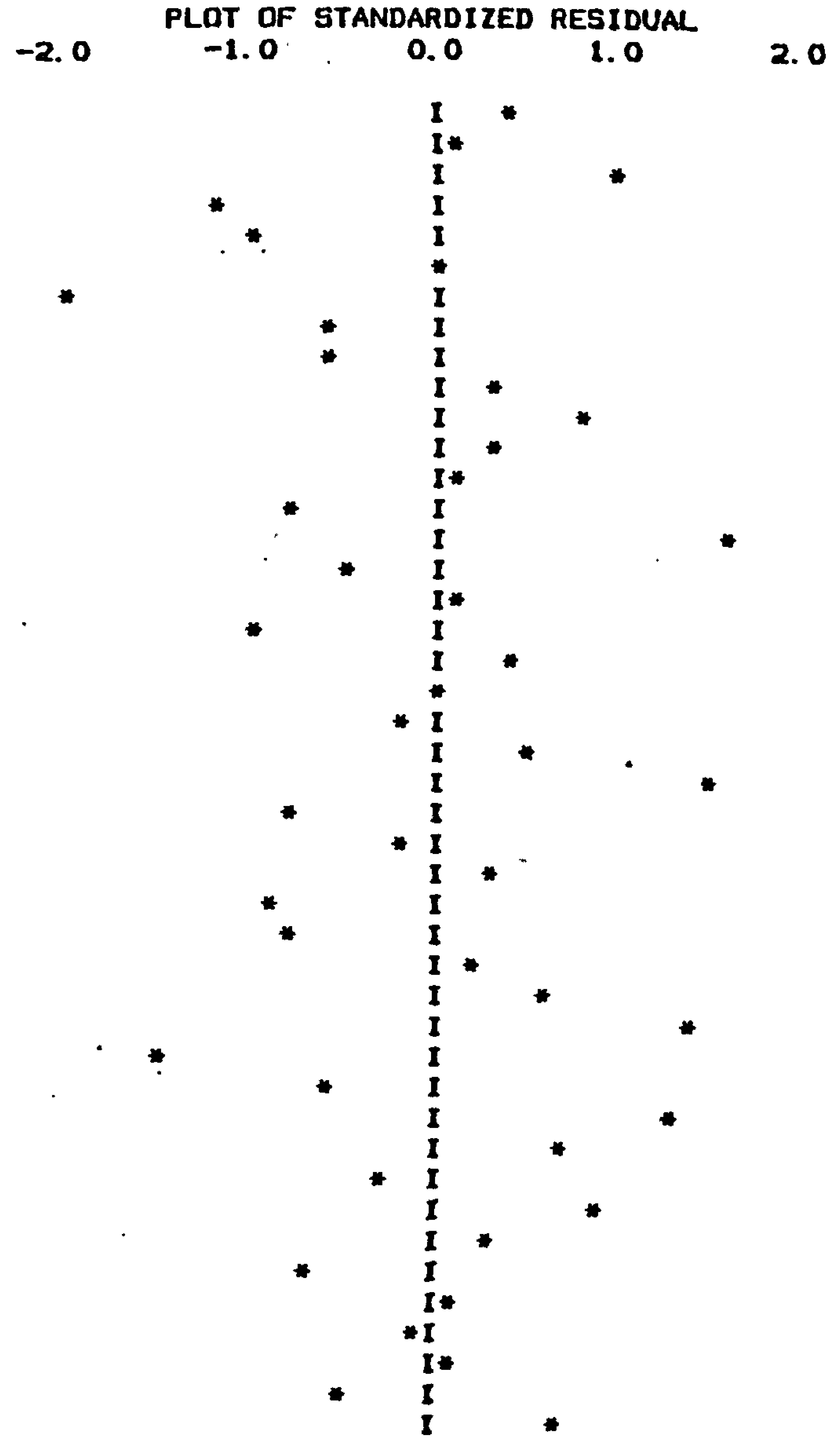
Area 16 - Multiple Regression Analysis for U with Variables I to R

* M U L T I P L E   R E G R E S S I O N * * * * * * * * * * * * * *

DEPENDENT VARIABLE: U   FROM VARIABLE LIST 1
REGRESSION LIST 1

SEQNUM	OBSERVED U	PREDICTED U	RESIDUAL
1	65.50000	55.88927	9.610729
2	51.80000	50.52940	1.270586
3	92.00000	69.04094	22.95905
4	25.50000	53.81741	-28.31741
5	42.50000	66.57826	-24.07827
6	62.10000	61.52641	0.5735811
7	35.00000	81.40727	-46.40729
8	42.50000	55.98083	-13.48083
9	25.00000	39.17873	-14.17873
10	56.00000	48.59854	7.401453
11	74.00000	55.36600	18.63399
12	76.00000	69.73091	6.269076
13	57.00000	55.47819	1.521812
14	27.00000	45.01049	-18.01050
15	84.00000	45.89187	38.10812
16	55.00000	65.97949	-10.97950
17	44.00000	41.55083	2.449159
18	46.00000	70.51184	-24.51184
19	64.00000	54.44011	9.559887
20	45.00000	45.17825	-0.1782540
21	36.75000	42.65374	-5.903749
22	64.00000	52.92999	11.07000
23	95.00000	60.35036	34.64963
24	22.20000	42.12070	-19.92072
25	29.20000	34.32190	-5.121905
26	73.00000	65.84486	7.155132
27	24.20000	46.35212	-22.15213
28	20.00000	37.90392	-17.90393
29	40.50000	35.09455	5.405447
30	56.00000	42.12070	13.87929
31	98.25999	64.29132	33.96866
32	32.00000	66.87035	-34.87035
33	51.00000	65.28452	-14.28452
34	88.84000	57.97588	30.86411
35	51.00000	35.06651	15.93348
36	51.00000	57.47527	-6.475273
37	84.00000	63.51068	20.48931
38	46.50000	38.42075	8.079250
39	15.50000	32.42728	-16.92728
40	36.00000	34.20555	1.794446
41	77.00000	78.39482	-1.394837
42	55.00000	52.31046	2.689537
43	32.00000	42.97925	-10.97926
44	60.00000	44.06940	15.93060



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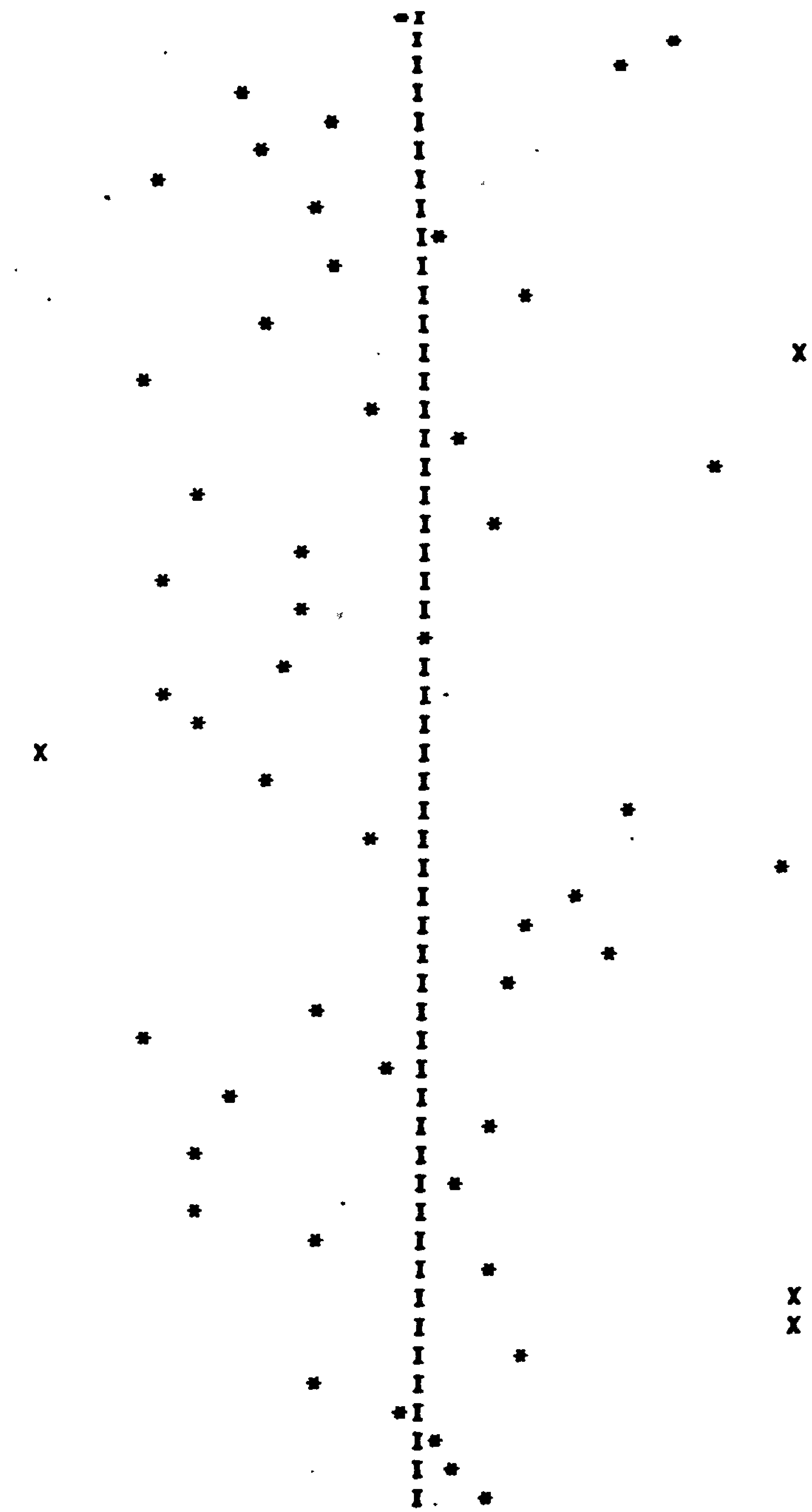
Area 16 - Plot of standardised residuals and table of observed and predicted U values

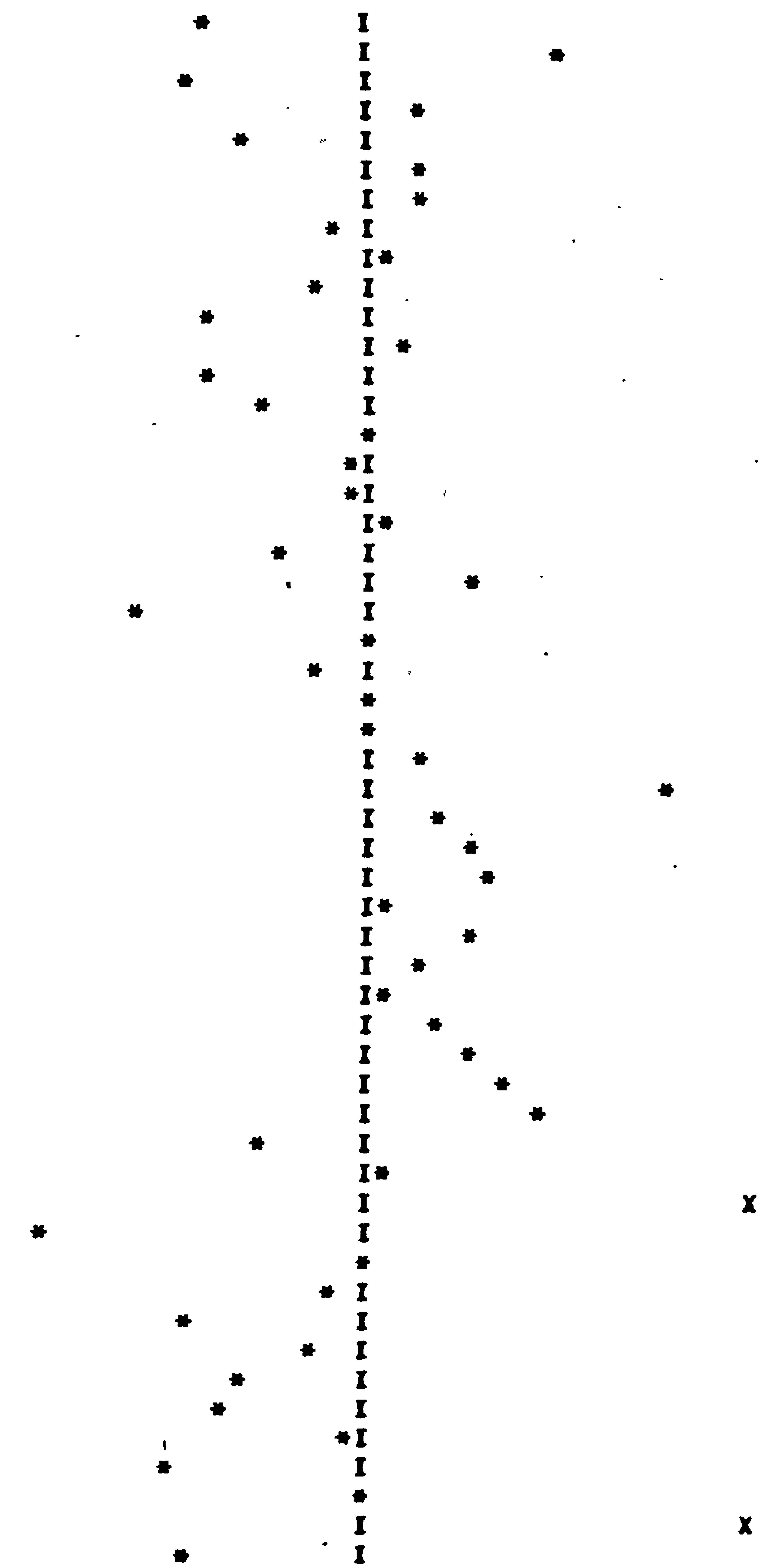
45	42.00000	43.57343	-1.573433
46	101.0000	66.09554	34.90445
47	74.00000	46.60424	27.39575
48	10.00000	34.87549	-24.87550
49	38.00000	48.72091	-10.72091
50	17.20000	38.26854	-21.06855
51	20.50000	55.03471	-34.53471
52	29.25000	44.12301	-14.87302
53	48.00000	46.78614	1.213854
54	36.00000	47.54704	-11.54704
55	53.00000	38.28206	14.71793
56	35.00000	55.33439	-20.33439
57	133.5000	79.20235	54.29763
58	32.50000	70.82365	-38.32367
59	35.00000	42.12070	-7.120710
60	56.00000	50.18627	5.813725
61	93.00000	52.16910	40.83089
62	30.50000	60.50835	-30.00835
63	60.50000	49.98809	10.51191
64	25.50000	42.12070	-16.62071
65	53.50000	88.24129	-34.74130
66	57.00000	73.82976	-16.82978
67	74.00000	72.85182	1.148165
68	44.00000	62.90740	-18.90741
69	34.00000	69.44945	-35.44946
70	40.00000	70.05832	-30.05832
71	26.00000	78.53848	-52.53849
72	44.00000	65.96558	-21.96558
73	86.00000	58.33157	27.66842
74	53.00000	59.59839	-6.598390
75	110.7400	61.45334	49.28664
76	105.0000	84.16786	20.83212
77	45.50000	30.62352	14.87647
78	76.00000	50.52457	25.47542
79	61.00000	48.63406	12.36594
80	28.00000	42.12070	-14.12071
81	38.00999	76.44655	-38.43657
82	53.00000	57.60410	-4.604105
83	34.00000	60.69025	-26.69025
84	81.50000	71.79044	9.709547
85	27.00000	57.87805	-30.87806
86	78.50000	73.82976	4.670226
87	42.00000	73.82976	-31.82978
88	67.50000	82.33438	-14.83439
89	70.89999	62.39747	8.502523
90	93.64999	37.45272	56.19727
91	119.4000	40.90572	78.49426
92	55.70000	41.75087	13.94912
93	50.20000	64.68015	-14.48016
94	55.80000	59.27675	-3.476761
95	70.31999	67.25385	3.066138
96	60.00000	55.88544	4.114551
97	75.96999	66.44595	9.524027



M-32 (Contd.)

Area 16 - Plot of standardised residuals and table of observed and predicted U values

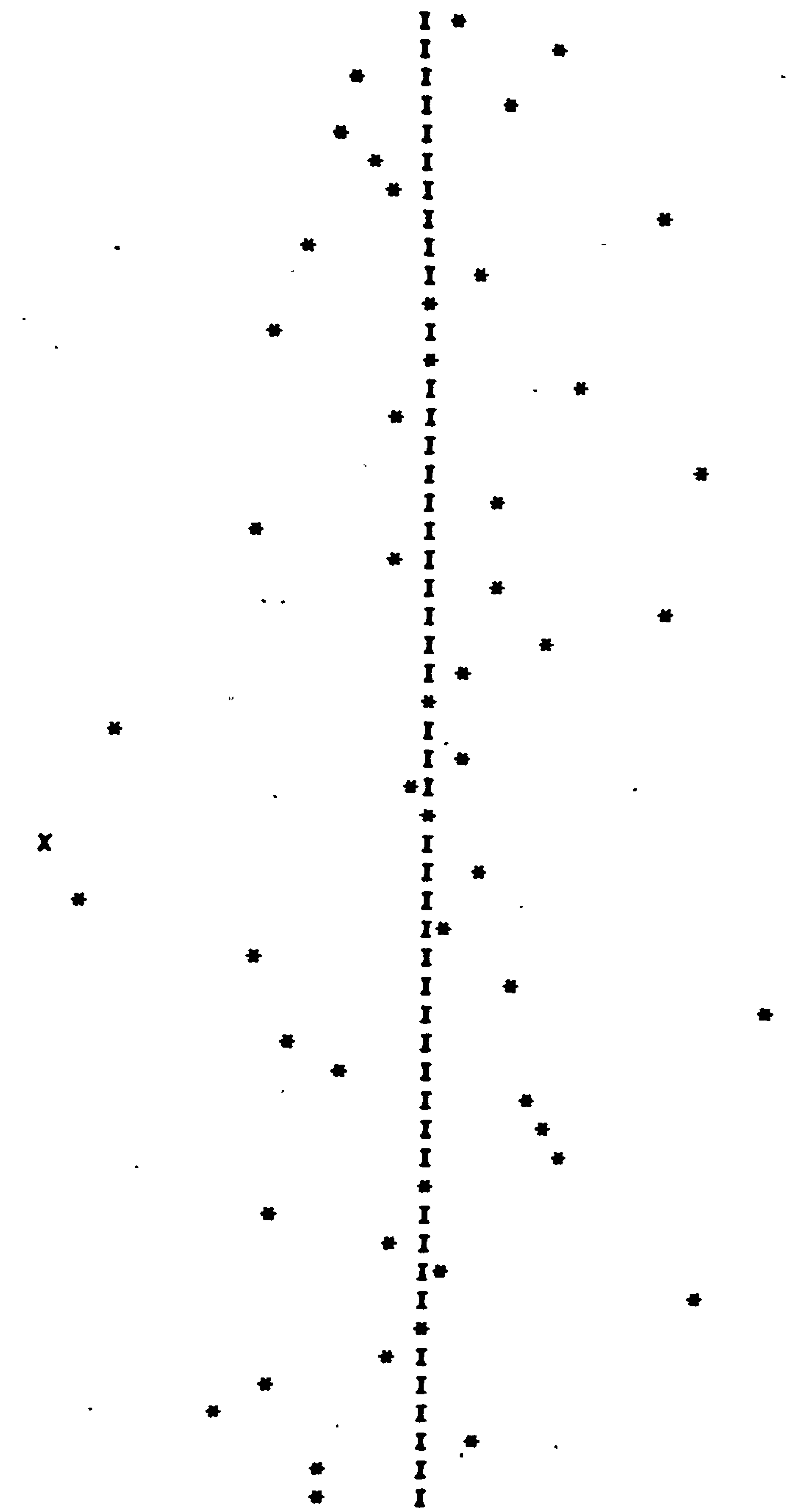
98	40.00000	62.34274	-22.34275
99	92.45000	65.26059	27.18940
100	18.75000	42.12070	-23.37071
101	80.00000	73.33105	6.668929
102	12.00000	28.77433	-16.77434
103	40.00000	33.13878	6.861217
104	50.00000	42.77009	7.229902
105	30.00000	35.25594	-5.255939
106	44.00000	42.12070	1.879290
107	23.00000	30.17000	-7.170005
108	14.00000	34.32190	-20.32190
109	43.35000	37.96881	5.381186
110	34.25000	56.61362	-22.36363
111	27.60000	41.55083	-13.95084
112	43.25000	42.12070	1.129290
113	52.50000	54.67578	-2.175789
114	39.50000	42.12070	-2.620710
115	30.00000	28.57430	1.425694
116	68.50000	80.06215	-11.56216
117	63.50000	49.15611	14.34388
118	15.82000	45.70274	-29.88274
119	64.00000	64.60767	-0.6076701
120	34.00000	40.82399	-6.823995
121	63.25000	64.02443	-0.7744344
122	36.50000	35.38841	1.111584
123	68.00000	60.51434	7.485661
124	121.0000	79.70073	41.29926
125	77.00000	67.73856	9.261429
126	69.20000	55.29417	13.90582
127	76.20000	59.85861	16.34138
128	63.50000	62.05480	1.445195
129	71.50000	57.31770	14.18230
130	97.00000	88.92932	8.070675
131	88.23999	86.03352	2.206457
132	74.00000	64.22662	9.773367
133	74.00000	59.77354	14.22645
134	85.00000	65.30762	19.69237
135	66.50000	42.12070	24.37929
136	26.76000	41.77237	-15.01238
137	82.00000	79.42508	2.574904
138	129.5000	77.98166	51.51833
139	37.39999	79.86018	-42.46021
140	49.00000	49.72841	-0.7284145
141	30.50000	35.51324	-5.013254
142	15.00000	37.77770	-22.77771
143	45.00000	51.00285	-6.002849
144	34.00000	50.80797	-16.80798
145	37.50000	56.73671	-19.23671
146	35.00000	37.96881	-2.968812
147	49.25000	74.88127	-25.63128
148	61.00000	60.08055	0.9194454
149	120.0000	65.41759	54.58240
150	30.25000	53.44353	-23.19354



M-32 (Contd.)

Area 16 - Plot of standardised residuals and table of observed and predicted U values

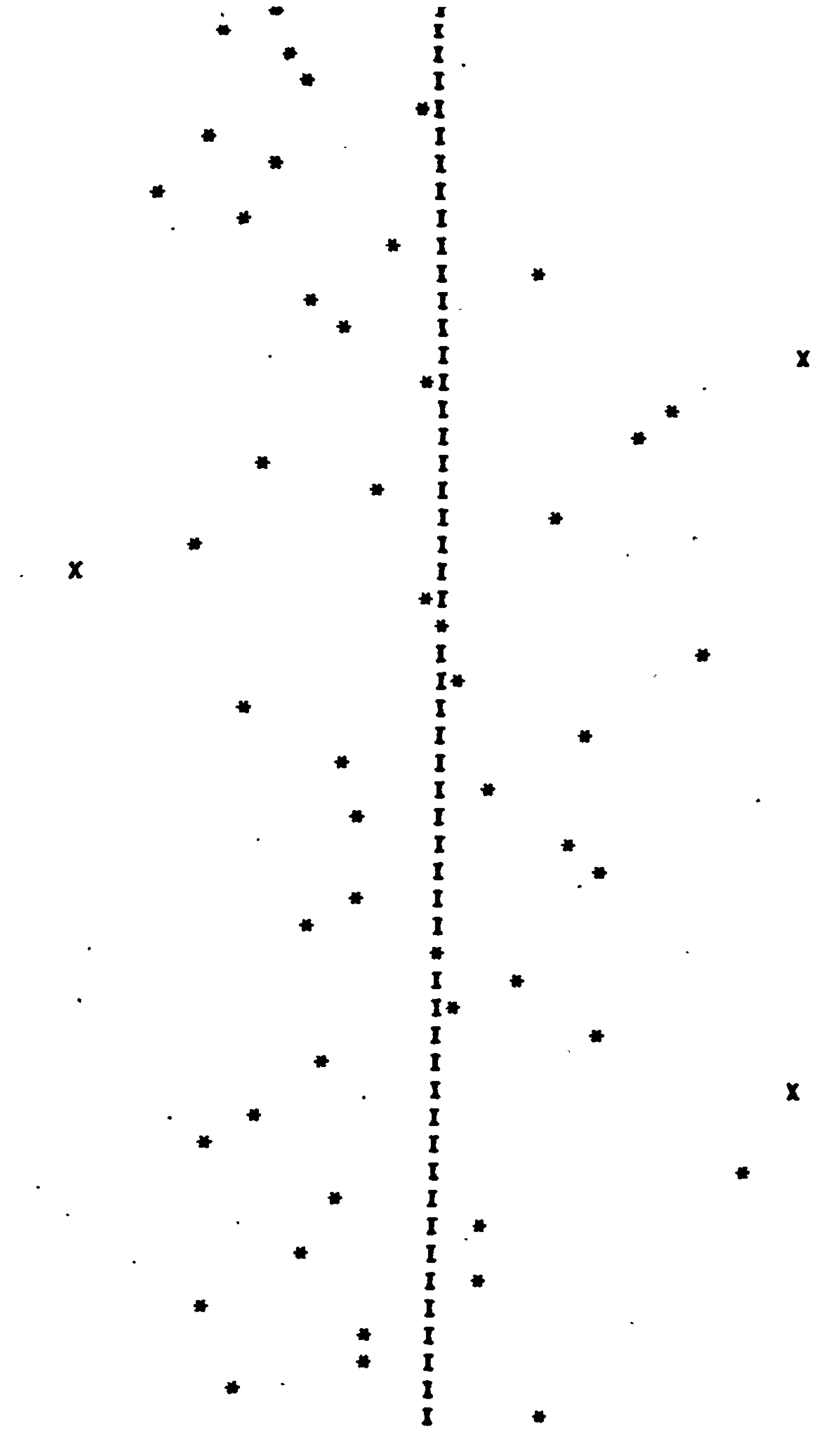
151	54.00000	48.26848	5.731514
152	90.00000	70.89229	19.10771
153	24.00000	34.26884	-10.26885
154	75.00000	64.20578	10.79420
155	54.50000	66.72331	-12.22333
156	44.50000	51.00285	-6.502849
157	33.00000	38.42075	-5.420750
158	101.5000	68.50919	32.99081
159	27.00000	43.61701	-16.61702
160	71.25000	65.03918	6.210802
161	34.30000	35.14341	-0.8434205
162	41.00000	62.44886	-21.44887
163	75.00000	74.00801	0.9919780
164	113.0000	91.82149	21.17850
165	40.00000	45.70274	-5.702739
166	185.5000	96.67772	88.82227
167	131.5000	93.02031	38.47968
168	86.00000	77.33545	8.664547
169	29.30000	53.06101	-23.76103
170	72.25000	76.21175	-3.961748
171	52.25000	42.77009	9.479902
172	78.00000	45.70274	32.29726
173	58.00000	42.12070	15.87929
174	64.00000	58.92673	5.073262
175	69.00000	69.14964	-0.1496557
176	15.00000	58.05762	-43.05763
177	46.00000	41.55083	4.449159
178	44.00000	47.51278	-3.512782
179	64.00000	63.42721	0.5727907
180	40.00000	104.0964	-64.09642
181	48.00000	39.70164	8.298347
182	40.50000	88.71333	-48.21335
183	44.50000	42.20022	2.299772
184	67.75000	91.34880	-23.59880
185	83.50000	70.47003	13.02996
186	116.5000	69.43642	47.06358
187	31.75000	50.75614	-19.00615
188	32.00000	43.59550	-11.59551
189	60.50000	47.09830	13.40169
190	47.50000	29.88385	17.61615
191	62.00000	43.52196	18.47803
192	61.50000	61.64276	-0.1427653
193	18.00000	38.64693	-20.64695
194	29.00000	34.32190	-5.321902
195	62.50000	59.04966	3.450336
196	109.0000	69.90849	39.09149
197	65.00000	65.19081	-0.1908147
198	75.00000	80.01941	-5.019414
199	51.75999	73.63322	-21.87325
200	51.00000	78.45338	-27.45339
201	85.00000	78.02611	6.973883
202	29.75000	44.19608	-14.44609
203	58.00000	72.85725	-14.85727



M-32 (Contd.)

Area 16 - Plot of standardised residuals and table of observed and predicted U values

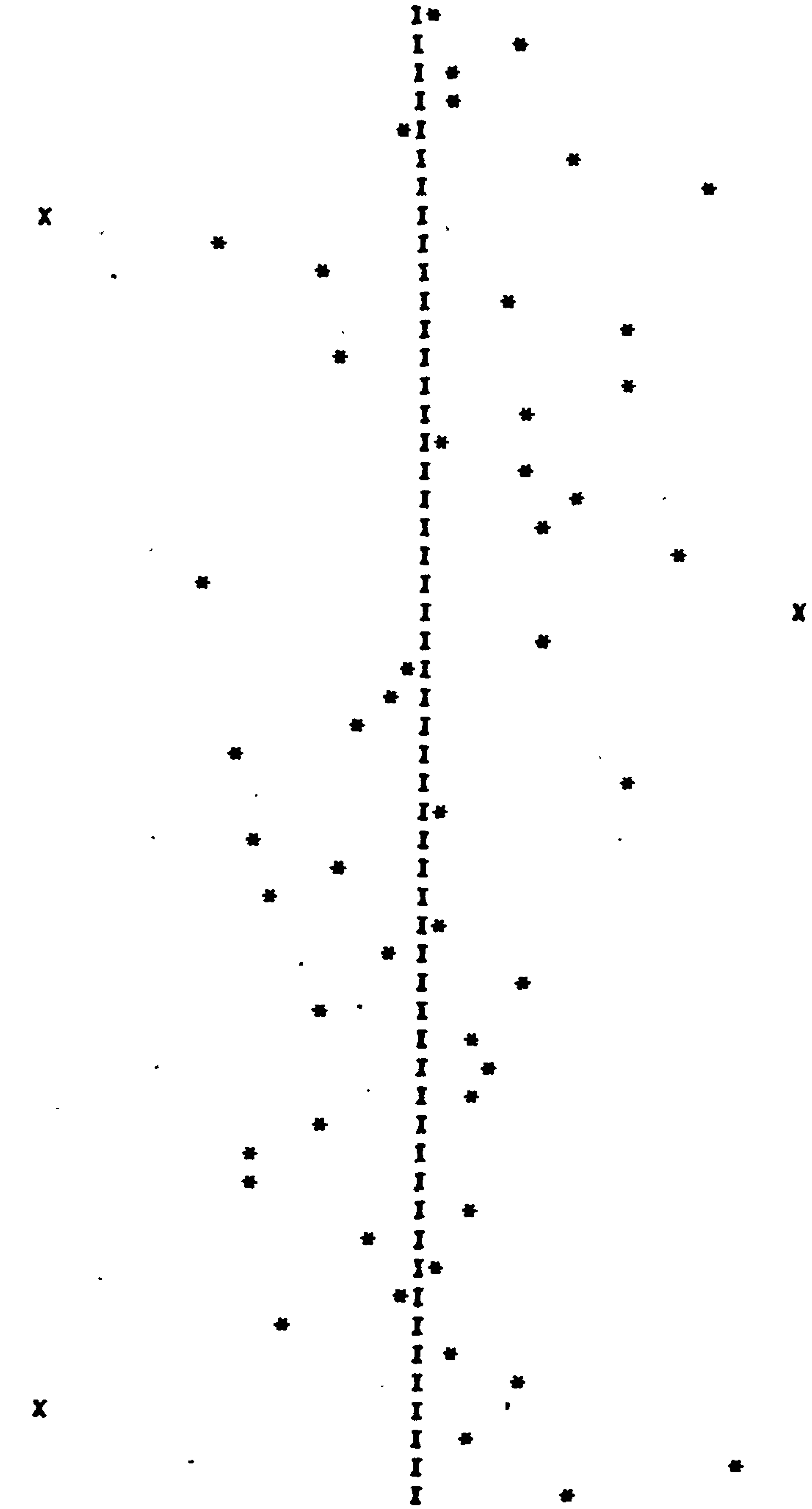
204	22.75000	45.70274	-22.95274	
205	61.50000	93.39542	-31.89543	
206	40.25000	62.13608	-21.88608	
207	22.25000	42.12070	-19.87071	
208	78.00000	80.70840	-2.708412	
209	18.50000	52.11943	-33.61944	
210	14.00000	37.96881	-23.96881	
211	29.60000	70.27339	-40.67340	
212	38.00000	66.88239	-28.88240	
213	52.00000	58.74799	-6.747994	
214	93.00000	78.43518	14.56481	
215	47.75000	65.90875	-18.15876	
216	32.00000	45.70274	-13.70274	
217	160.5000	83.67242	76.82756	
218	59.00000	62.54117	-3.541174	
219	101.0000	67.69504	33.30495	
220	91.00000	61.65980	29.34020	
221	44.00000	69.50331	-25.50333	
222	61.25000	69.87877	-8.628775	
223	54.00000	36.57314	17.42685	
224	40.25999	75.61095	-35.35096	
225	36.00000	100.0981	-64.09816	
226	45.39999	47.24935	-1.849362	
227	124.0000	123.2591	0.7409089	
228	120.0000	83.06862	36.93136	
229	35.80000	34.42802	1.371969	
230	27.75000	55.55641	-27.80642	
231	74.50000	53.97894	20.52105	
232	17.00000	30.17000	-13.17001	
233	55.00000	47.51402	7.485981	
234	28.20000	39.37143	-11.17144	
235	72.00000	52.01382	19.98617	
236	86.70000	63.72984	22.97016	
237	55.00000	65.90642	-10.90643	
238	32.50000	51.98959	-19.48959	
239	42.00000	42.12070	-0.1207097	
240	53.00000	42.12070	10.87929	
241	75.00000	72.05681	2.943186	
242	105.0000	80.63841	24.36158	
243	26.35000	42.12070	-15.77071	
244	148.0000	89.39690	58.60310	
245	16.00000	42.62569	-26.62570	
246	35.00000	68.84480	-33.84483	
247	145.0000	98.95706	46.04293	
248	85.00000	99.91779	-14.91780	
249	57.00000	50.42450	6.575495	
250	51.75000	71.61073	-19.86075	
251	81.29999	73.82976	7.470214	
252	37.50000	69.83020	-32.33022	
253	43.00000	52.65446	-9.654463	
254	76.00000	86.03284	-10.03284	
255	17.50000	46.20772	-28.70773	
256	94.75000	77.22076	17.52922	



M-32 (Contd.)

Area 16 - Plot of standardised residuals and table of observed and predicted U values

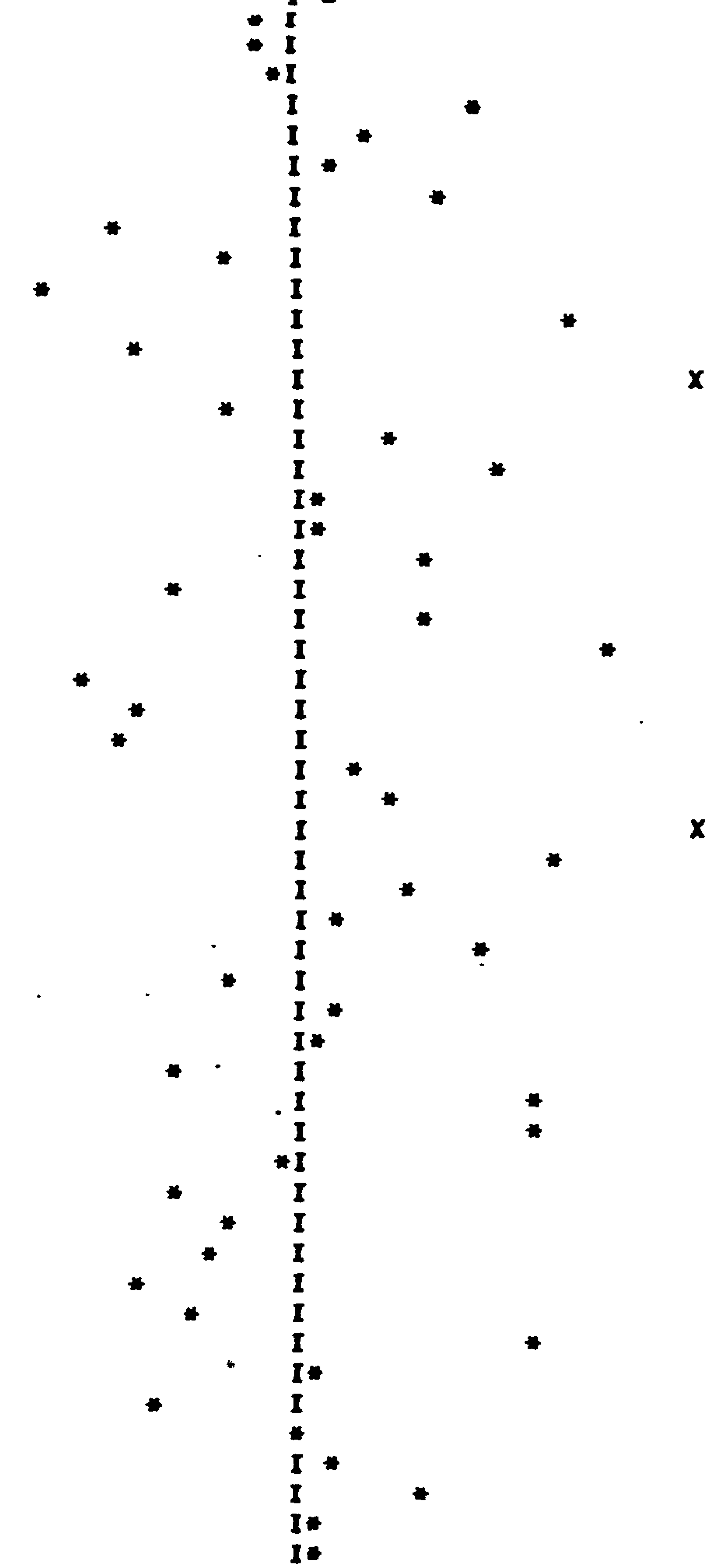
257	70.64999	68.30811	2.341874
258	75.78999	62.15662	13.63337
259	42.00000	37.90392	4.096069
260	43.00000	38.28056	4.719440
261	59.50000	61.11126	-1.611267
262	92.34999	71.57036	20.77962
263	91.75000	50.56672	41.18327
264	20.00000	87.14607	-67.14609
265	30.74000	58.19241	-27.45242
266	43.00000	58.12476	-15.12476
267	97.00000	85.02188	11.97811
268	85.00000	56.57449	28.42551
269	71.50000	84.13258	-12.63259
270	122.7300	94.19449	28.53549
271	77.00000	62.90343	14.09657
272	69.00000	67.22054	1.779461
273	79.75000	64.79547	14.95452
274	98.25000	77.98166	20.26833
275	75.00000	58.34720	16.65280
276	86.00000	51.23185	34.76814
277	29.50000	59.36397	-29.86398
278	169.5600	88.19640	81.36356
279	102.0000	85.34863	16.65135
280	75.50000	77.46558	-1.965583
281	68.00000	73.66202	-5.662024
282	48.00000	56.55740	-8.557409
283	40.00000	65.43431	-25.43432
284	80.00000	51.94714	28.05285
285	53.00000	49.79492	3.205076
286	65.84000	89.56560	-23.72561
287	62.00000	72.76675	-10.76676
288	46.00000	68.35674	-22.35675
289	48.39999	46.00633	2.393660
290	38.20000	42.12070	-3.920713
291	73.00000	58.78039	14.21961
292	24.00000	37.96881	-13.96881
293	55.00000	46.98679	8.013201
294	54.00000	44.95698	9.043015
295	35.00000	28.77433	6.225662
296	46.00000	61.09060	-15.09060
297	35.95000	60.84755	-24.89756
298	47.25999	70.72789	-23.46791
299	55.00000	47.09830	7.901693
300	58.50000	65.58925	-7.089254
301	44.25000	42.12070	2.129290
302	89.50000	92.83247	-3.332485
303	45.95999	64.54672	-18.58675
304	81.00000	75.73810	5.261900
305	70.00000	56.57802	13.42197
306	20.30000	77.80730	-57.50732
307	52.89999	46.27261	6.627386
308	104.6000	58.44721	46.15277
309	76.64999	54.31876	22.33122



M-32 (Contd.)

Area 16 - Plot of standardised residuals and table of observed and predicted U values

311	45.00000	49.67610	-4.676110
312	87.50000	91.91855	-4.418557
313	65.25000	68.35573	-3.105739
314	105.9900	82.86720	23.12278
315	63.50000	54.00653	9.493465
316	84.00000	79.38989	4.610090
317	84.50000	65.98569	18.51431
318	66.00000	90.47614	-24.47615
319	81.50000	90.28592	-8.785927
320	56.25000	89.18701	-32.93703
321	81.50000	46.35212	35.14787
322	39.50000	61.74406	-22.24406
323	151.0000	75.94987	75.05011
324	56.39999	65.33495	-8.934959
325	65.75000	53.21006	12.53993
326	72.09999	46.27261	25.82738
327	53.24000	51.58447	1.655531
328	44.00000	42.05582	1.944172
329	74.00000	56.26381	17.73618
330	17.70000	34.32190	-16.62191
331	61.25000	45.70274	15.54726
332	106.1200	65.60303	40.51695
333	29.00000	57.13837	-28.13838
334	46.00000	66.38420	-20.38422
335	22.30000	45.70274	-23.40274
336	111.5000	103.9611	7.538851
337	102.5000	89.77763	12.72235
338	100.5000	42.05582	58.44417
339	84.29999	51.54282	32.75716
340	73.50000	60.03735	13.46265
341	78.64999	73.09215	5.557839
342	91.00000	66.29132	24.70868
343	47.75999	57.87131	-10.11132
344	44.50000	40.79588	3.704116
345	40.50000	37.96881	2.531188
346	28.00000	44.06234	-16.06235
347	92.00000	62.26405	29.73594
348	101.5000	70.62819	30.87181
349	39.50000	42.12070	-2.620710
350	48.25000	64.42210	-16.17211
351	43.50000	52.77961	-9.279612
352	43.95000	55.56568	-11.61569
353	38.50000	60.25518	-21.75518
354	31.50000	45.70274	-14.20274
355	88.00000	56.27724	31.72276
356	73.25000	72.03363	1.216367
357	38.50000	57.87131	-19.37132
358	75.00000	74.39963	0.6003579
359	50.00000	45.70274	4.297261
360	65.75000	48.65483	17.09516
361	60.00000	57.65344	2.346556
362	43.50000	42.12070	1.379290



M-32 (Contd.)

Area 16 - Plot of standardised residuals and table of observed and predicted U values

APPENDIX N

FILE F1 (CREATION DATE = 06/17/83)

* M U L T I P L E   R E G R E S S I O N * * * * * * * * * * * * * * * * VARIABLE LIST / REGRESSION LIST

DEPENDENT VARIABLE.. U

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
H1	0.32262	0.10408	0.10408	0.32262	0.176[illegible]	0.247
S1	0.35960	0.12931	0.02523	0.26367	0.7487[illegible]	0.171[illegible]
E1	(0.12) 0.36103	0.13038	0.00107	-0.29008	0.4[illegible]071E-01	0.0[illegible]
(CONSTANT)					29.[illegible]671	

N-1

Area 16 - Multiple Regression Analysis for U with Unweighted E1, S1, H1

FILE F1 (CREATION DATE = 06/17/83)

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * VARIABLE LIST 1
REGRESSION LIST 1

DEPENDENT VARIABLE.. U

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
[illegible]	0.32165	0.10346	0.10346	0.32165	0.2313174	0.73[illegible]7
[illegible]	0.36341	0.13207	0.02861	0.32143	1.14215[illegible]	[illegible].24[illegible]1
[illegible]	(0.13) 0.37421	0.14003	0.00756	-0.26547	0.1805[illegible]	[illegible].156[illegible]
(CONSTANT)					19.6[illegible]	

N-2

Area 16 - Multiple Regression Analysis for U with Weighted E1, S1, H1

APPENDIX O

FILE F1 (CREATION DATE = 06/21/83)

* M U L T I P L E   R E G R E S S I O N * * * * * * * * * * * * *   VARIABLE LIST 1
REGRESSION LIST 1

DEPENDENT VARIABLE.. U

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
S1	0.20218	0.04088	0.04088	0.20218	2.883195	0.42114
H1	0.41419	0.17155	0.13068	-0.17729	-0.4561295	-0.49838
E1	(0.c2) 0.41779	0.17455	0.00259	-0.01048	-0.8360654E-01	-0.09939
(CONSTANT)					10.45552	

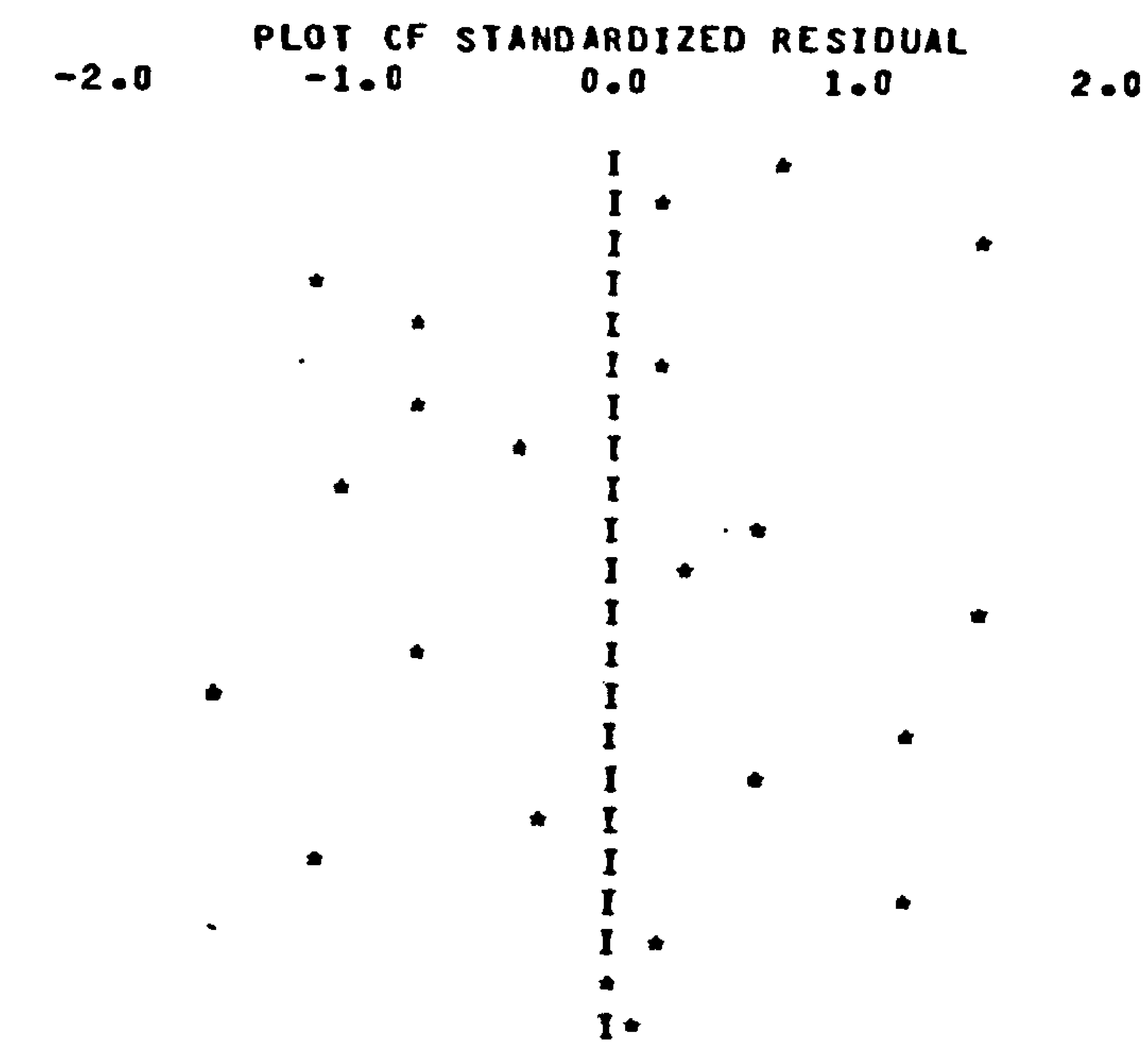
O-1

Area 1 - Multiple Regression Analysis for U with E1, S1, H1 (Area Weighted)

* M U L T I P L E   R E G R E S S I C N * * * * * * * * * * * * *

DEPENDENT VARIABLE: U   FROM VARIABLE LIST 1
REGRESSION LIST 1

SEQNUM	OBSERVED U	PREDICTED U	RESIDUAL
1	22.00000	10.57284	11.42716
2	25.85000	22.68589	3.164106
3	46.00000	23.65402	22.34598
4	0.0000000	18.80424	-18.80424
5	0.0000000	12.69765	-12.69765
6	22.50000	20.03061	2.469392
7	15.75000	28.35869	-12.60870
8	0.0000000	6.804489	-6.804490
9	0.0000000	16.93643	-16.93644
10	28.00000	19.44630	8.553696
11	37.00000	31.86825	5.131749
12	38.00000	14.52838	23.47161
13	0.0000000	12.59114	-12.59114
14	0.0000000	24.73631	-24.73632
15	42.00000	23.03024	18.96975
16	27.50000	17.87572	9.624279
17	22.00000	26.15684	-4.156845
18	0.0000000	17.56231	-17.56232
19	32.00000	14.13578	17.86422
20	22.50000	19.21556	3.284439
21	15.50000	16.09995	-0.5999521
22	32.00000	30.80832	1.191682



DURBIN-WATSON TEST OF RESIDUAL DIFFERENCES COMPARED BY CASE ORDER (SEQNUM).

VARIABLE LIST 1, REGRESSION LIST 1.   DURBIN-WATSON TEST 2.16542

0-2

Area 1 - Plot of standardised residuals and table of observed and predicted U values w.r.t. E1, H1, S1 (area weighted)

FILE F1 (CREATION DATE = 06/21/83)

* M U L T I P L E   R E G R E S S I O N * * * * * * * * * * * * * VARIABLE LIST 1
REGRESSION LIST 1

DEPENDENT VARIABLE.. U

SUMMARY TABLE

VARIABLE		MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
E1	(0.25)	0.54138	0.29310	0.29310	-0.54138	-0.2352022	-0.38544
S1		0.54760	0.29987	0.00677	0.47818	0.6599543	0.14691
H1		0.54829	0.30062	0.00075	0.44289	0.3515865E-01	0.04900
(CONSTANT)						32.96856	

0-3

Area 2 - Multiple Regression Analysis for U with El, Sl, Hl (Area Weighted)

```
* * * * * * * * * * * * * * * * * * * * * * *  M U L T I P L E   R E G R E S S I C N  * * * * * * * * * * * * * * * *

DEPENDENT VARIABLE:  U        FROM    VARIABLE LIST  1
                                    REGRESSION LIST  1

            OBSERVED         PREDICTED                            PLOT CF STANDARDIZED RESIDUAL
SEQNUM         U                 U          RESIDUAL          -2.0      -1.0      0.0       1.0       2.0

    1      36.00000         28.61482        7.385175                              I     *
    2      0.0000000        8.594282       -8.594286                       *      I
    3      14.60000         8.562641        6.037356                              I    *
    4      36.50000         26.24408        10.25592                              I       *
    5      0.0000000        10.94486       -10.94486                      *       I
    6      0.0000000        9.156599       -9.156601                       *      I
    7      15.50000         23.19923       -7.699232                        *     I
    8      28.00000         8.594282        19.40571                              I              *
    9      15.63000         30.41454       -14.78454                   *          I
   10      16.00000         25.47334       -9.473343                       *      I
   11      14.50000         16.25567       -1.755676                             *I
   12      31.17000         29.62512        1.544874                              I*
   13      25.50000         19.79183        5.708168                              I   *
   14      0.0000000        21.24506       -21.24507              *               I
   15      42.00000         23.68673        18.31327                              I             *
   16      20.00000         19.69141        0.3085926                             *
   17      0.0000000        10.84449       -10.84449                      *       I
   18      18.00000         11.00944        6.990561                              I    *
   19      38.50000         19.95155        18.54845                              I             *

DURBIN-WATSON TEST OF RESIDUAL DIFFERENCES COMPARED BY CASE ORDER (SEQNUM).

VARIABLE LIST  1, REGRESSION LIST  1.    DURBIN-WATSON TEST    2.40997
```

0-4

Area 2 - Plot of standardised residuals and table of observed and predicted U values w.r.t. El, Hl, Sl (area weighted)

FILE F1 (CREATION DATE = 06/21/83)

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * VARIABLE LIST 1
REGRESSION LIST 1

DEPENDENT VARIABLE.. U

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
S1	0.35333	0.12484	0.12484	0.35333	1.501538	0.33996
H1	0.36456	0.13290	0.00806	0.14083	0.7111245E-01	0.09075
(CONSTANT)					10.78190	

(o o)

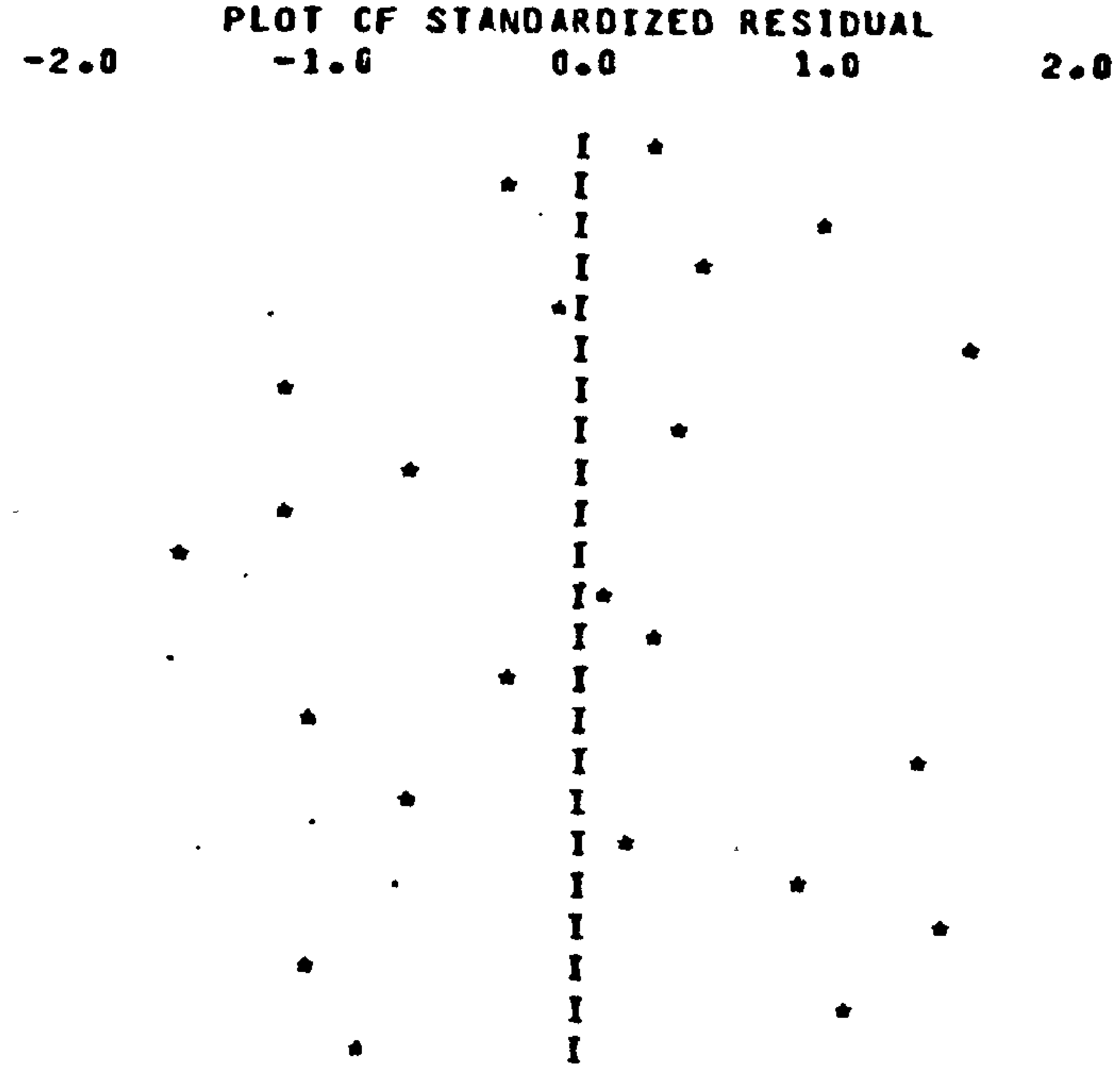
0-5

Area 3 - Multiple Regression Analysis for U with E1, S1, H1 (Area Weighted)

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * *

DEPENDENT VARIABLE: U FROM VARIABLE LIST 1
REGRESSION LIST 1

SEQNUM	OBSERVED U	PREDICTED U	RESIDUAL
1	18.00000	13.72531	4.274690
2	16.00000	21.01884	-5.018842
3	30.00000	15.02528	14.97472
4	21.00000	14.21459	6.785406
5	33.00000	33.86756	-0.8675654
6	37.00000	13.32217	23.67783
7	0.0000000	17.56530	-17.56531
8	19.00000	13.22751	5.772486
9	0.0000000	10.87565	-10.87566
10	0.0000000	17.73793	-17.73793
11	0.0000000	23.78560	-23.78561
12	17.50000	15.37699	2.123006
13	18.00000	12.97453	5.025467
14	19.00000	23.22684	-4.226847
15	0.0000000	17.12636	-17.12637
16	47.00000	26.23245	20.76755
17	0.0000000	11.12626	-11.12626
18	17.50000	14.18230	3.317696
19	28.00000	14.07294	13.92706
20	46.50000	24.23117	22.26883
21	0.0000000	16.33431	-16.33432
22	30.25000	14.31775	15.93225
23	0.0000000	14.18230	-14.18230



DURBIN-WATSON TEST OF RESIDUAL DIFFERENCES COMPARED BY CASE ORDER (SEQNUM).

VARIABLE LIST 1, REGRESSION LIST 1. DURBIN-WATSON TEST 2.43354

0-6

Area 3 - Plot of standardised residuals and table of observed and predicted U values w.r.t. E1, H1, S1 (area weighted)

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FILE   F1       (CREATION DATE = 06/21/83)

* * * * * * * * * * * * * * * * * * * * * * *  M U L T I P L E   R E G R E S S I O N  * * * * * * * * * * * * *   VARIABLE LIST  1
                                                                                                                  REGRESSION LIST  1
DEPENDENT VARIABLE..   U
```

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
E1	0.23172	0.05369	0.05369	-0.23172	-0.4046519	-0.25112
S1	(c.o) 0.23941	0.05732	0.00363	0.01375	-0.1725243	-0.06327
(CONSTANT)					23.46428	

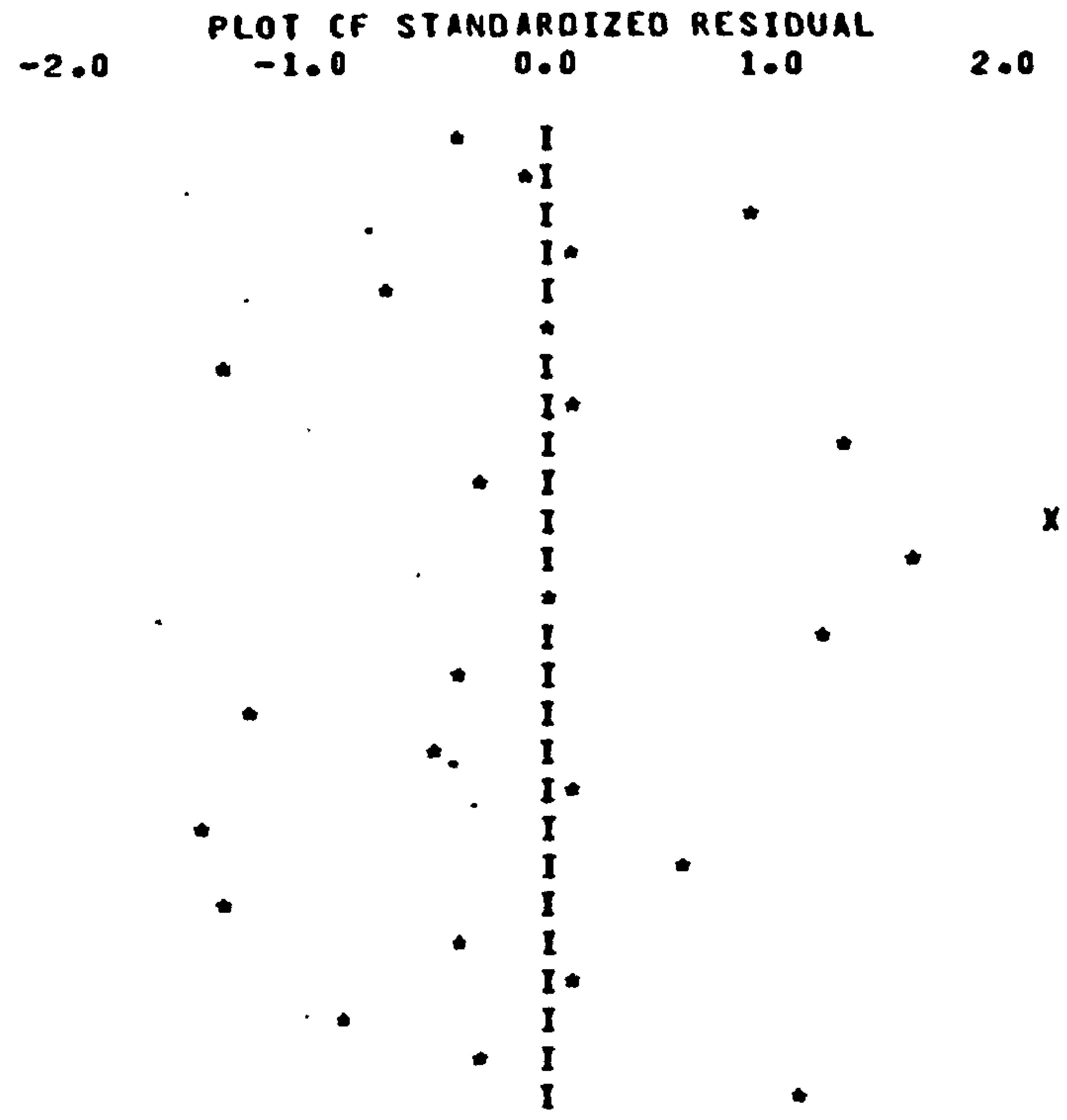
0-7

Area 4 - Multiple Regression Analysis for U with El, Sl, Hl (Area Weighted)

* M U L T I P L E   R E G R E S S I C N * * * * * * * * * * * * * * *

DEPENDENT VARIABLE: U   FROM   VARIABLE LIST 1
REGRESSION LIST 1

SEQNUM	OBSERVED U	PREDICTED U	RESIDUAL
1	21.75000	26.99574	-5.245747
2	18.00000	20.18975	-2.189749
3	37.00000	24.00884	12.99116
4	22.00000	20.16590	1.834092
5	17.00000	26.73696	-9.736961
6	20.00000	20.28667	-0.2866751
7	0.0000000	20.09941	-20.09941
8	22.00000	20.18975	1.810251
9	43.00000	23.75853	19.24147
10	22.25000	26.63344	-4.383446
11	55.37000	20.28667	35.08331
12	52.50000	29.15607	23.34393
13	22.75000	22.39272	0.3572730
14	38.00000	20.32777	17.67223
15	20.75000	27.30377	-6.553776
16	0.0000000	18.75086	-18.75086
17	16.88000	24.22027	-7.340275
18	23.00000	22.01192	0.9880821
19	0.0000000	21.71204	-21.71204
20	32.50000	23.43355	9.066446
21	0.0000000	20.09282	-20.09283
22	14.00000	20.06898	-6.068983
23	21.00000	20.06898	0.9310176
24	20.25000	33.04606	-12.79606
25	20.00000	24.08381	-4.083813
26	37.50000	21.47865	16.02135



DURBIN-WATSON TEST OF RESIDUAL DIFFERENCES COMPARED BY CASE ORDER (SEQNUM).

VARIABLE LIST 1, REGRESSION LIST 1.   DURBIN-WATSON TEST   1.77820

0-8

Area 4 – Plot of standardised residuals and table of observed and predicted U values w.r.t. E1, H1, S1 (area weighted)

FILE F1 (CREATION DATE = 06/21/83)

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * VARIABLE LIST 1
REGRESSION LIST 1

DEPENDENT VARIABLE.. U

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
H1	0.29111	0.08475	0.08475	0.29111	0.8010698E-01	0.22230
S1	(o.c) 0.30084	0.09050	0.00576	0.25177	0.3065240	0.10243
(CONSTANT)					18.80796	

0-9

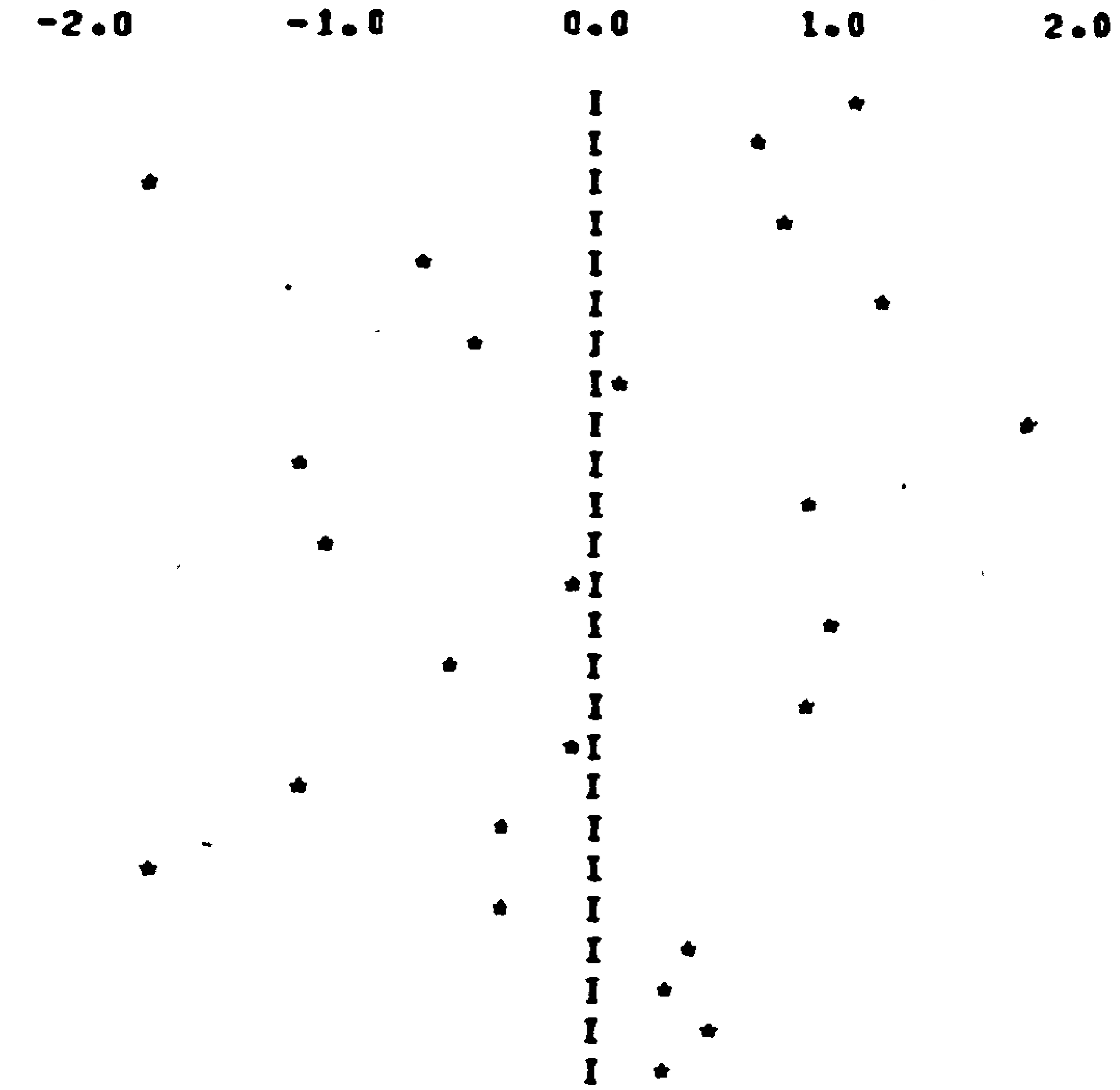
Area 5 - Multiple Regression Analysis for U with E1, S1, H1 (Area Weighted)

* M U L T I P L E R E G R E S S I C N * * * * * * * * * * * * * * *

DEPENDENT VARIABLE: U FROM VARIABLE LIST 1
REGRESSION LIST 1

SEQNUM	OBSERVED U	PREDICTED U	RESIDUAL
1	24.45000	12.67720	11.77280
2	20.85000	12.84721	8.002789
3	0.0000000	19.13639	-19.13640
4	27.90000	19.01835	8.881641
5	12.00000	19.20326	-7.203264
6	30.00000	17.51678	12.48322
7	13.97000	19.23425	-5.264252
8	20.00000	18.54427	1.455731
9	38.00000	18.77697	19.22302
10	0.0000000	12.87786	-12.87786
11	31.50000	21.83420	9.665796
12	0.0000000	12.35399	-12.35399
13	13.00000	14.48569	-1.485691
14	25.00000	14.02339	10.97661
15	9.750000	16.08855	-6.338557
16	22.00000	12.60199	9.398008
17	11.50000	12.56856	-1.068557
18	0.0000000	12.53790	-12.53790
19	8.049999	12.63264	-4.582644
20	0.0000000	19.81532	-19.81532
21	7.799999	12.51003	-4.710034
22	16.75000	12.87786	3.872138
23	22.50000	19.23848	3.261517
24	18.00000	12.87786	5.122137
25	15.00000	11.74094	3.259058

PLOT CF STANDARDIZED RESIDUAL



DURBIN-WATSON TEST OF RESIDUAL DIFFERENCES COMPARED BY CASE ORDER (SEQNUM).

VARIABLE LIST 1. REGRESSION LIST 1. DURBIN-WATSON TEST 2.54330

0-10

Area 5 - Plot of standardised residuals and table of observed and predicted U values w.r.t. E1, H1, S1 (area weighted)

FILE F1 (CREATION DATE = 06/21/83)

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * VARIABLE LIST 1
REGRESSION LIST 1

DEPENDENT VARIABLE.. U

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
H1	•0.65084	0.42359	0.42359	0.65084	0.5257291	0.87464
E1	•0.65891	0.43416	0.01057	-0.43767	0.4772634	0.23441
S1	(0.34)•0.66098	0.43690	0.00274	0.36422	-1.153648	-0.88169
(CONSTANT)					29.92819	

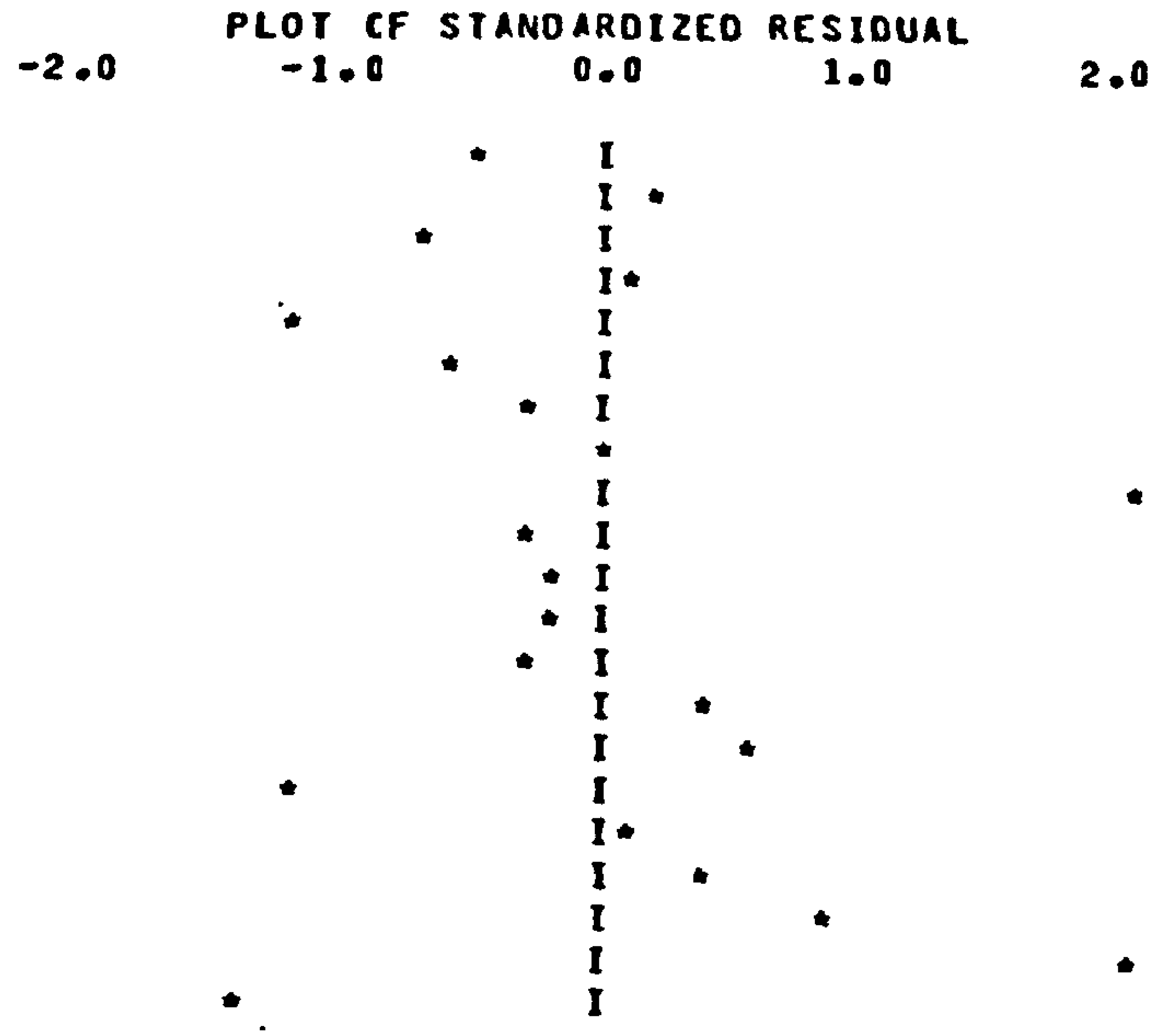
0-11

Area 6 - Multiple Regression Analysis for U with E1, S1, H1 (Area Weighted)

* M U L T I P L E R E G R E S S I C N * * * * * * * * * * * * *

DEPENDENT VARIABLE: U FROM VARIABLE LIST 1
REGRESSION LIST 1

SEQNUM	OBSERVED U	PREDICTED U	RESIDUAL
1	27.00000	32.77227	-5.772277
2	31.75000	29.23059	2.519410
3	3.270000	11.23693	-7.966932
4	32.00000	31.04990	0.9500940
5	17.00000	29.42919	-12.42920
6	27.00000	33.54379	-6.543800
7	18.25000	21.57033	-3.320335
8	34.00000	34.28812	-0.2881302
9	60.50000	37.82316	22.67683
10	31.00000	33.98713	-2.987138
11	29.00000	30.70075	-1.700754
12	32.00000	34.25484	-2.254847
13	31.75000	34.55732	-2.807322
14	35.75000	31.94121	3.808787
15	46.25000	39.48527	6.764724
16	30.36000	43.56824	-13.20825
17	37.00000	35.65270	1.347291
18	37.00000	32.83136	4.168633
19	42.50000	33.18706	9.312941
20	33.25000	10.31401	22.93599
21	0.0000000	15.20572	-15.20572



DURBIN-WATSON TEST OF RESIDUAL DIFFERENCES COMPARED BY CASE ORDER (SEQNUM).

VARIABLE LIST 1, REGRESSION LIST 1. DURBIN-WATSON TEST 2.06107

0-12

Area 6 - Plot of standardised residuals and table of observed and predicted U values w.r.t. El, Hl, Sl (area weighted)

FILE F1 (CREATION DATE = 06/21/83)

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * * VARIABLE LIST 1
REGRESSION LIST 1

DEPENDENT VARIABLE.. U

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
H1	0.50466	0.25468	0.25468	0.50466	0.7588914	0.42913
S1	(0.20) 0.51353	0.26372	0.00904	0.32487	0.5938103	0.11381
E1	0.51474	0.26495	0.00124	-0.27640	-0.5483224E-01	-0.04130
(CONSTANT)					22.30959	

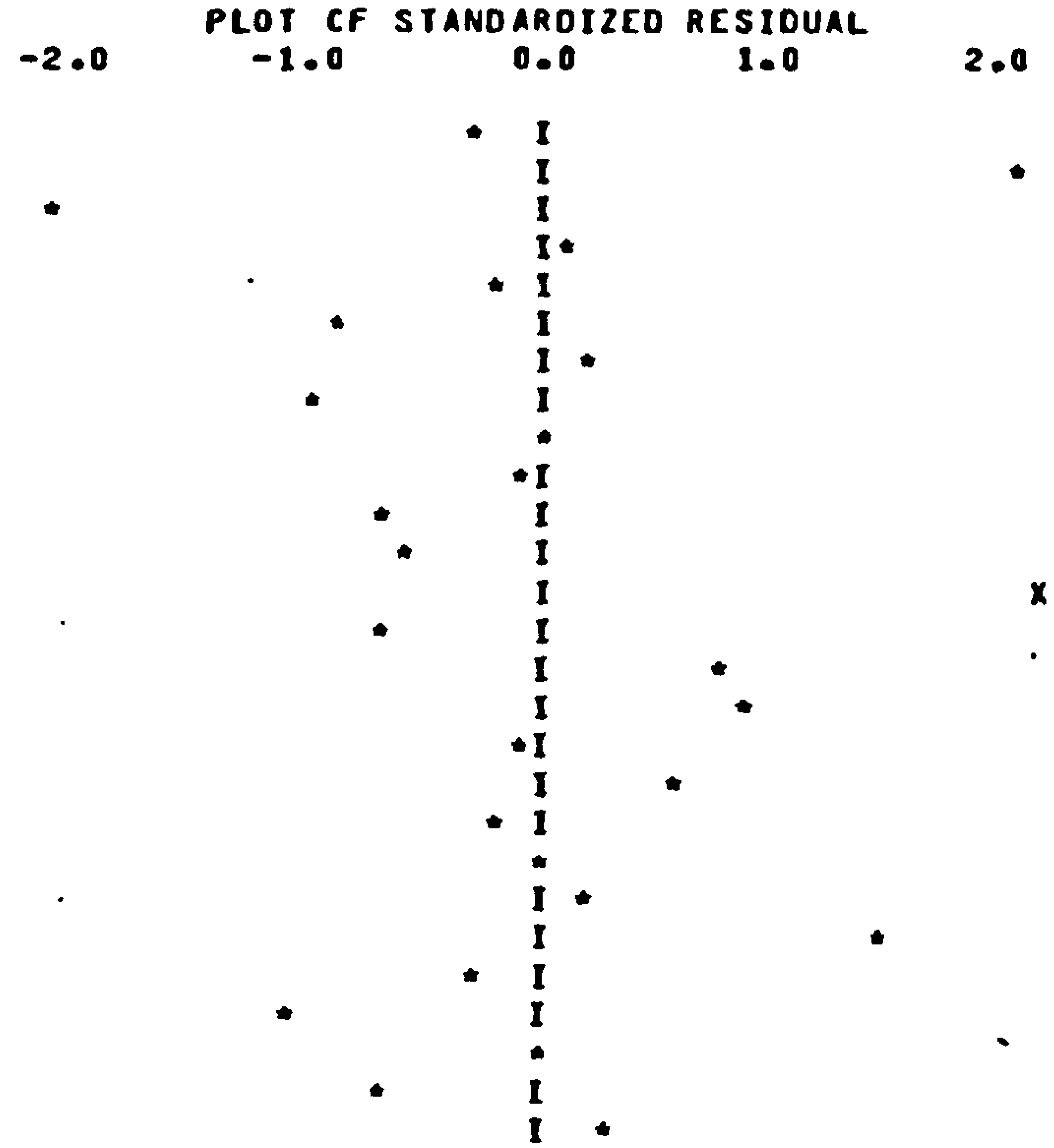
0-13

Area 7 - Multiple Regression Analysis for U with E1, S1, H1 (Area Weighted)

* M U L T I P L E   R E G R E S S I C N * * * * * * * * * * * * * * *

DEPENDENT VARIABLE: U FROM VARIABLE LIST 1
REGRESSION LIST 1

SEQNUM	OBSERVED U	PREDICTED U	RESIDUAL
1	29.50000	33.39782	-3.897823
2	64.75000	33.20577	31.54422
3	0.0000000	31.34402	-31.34402
4	17.75000	15.48734	2.262657
5	15.25000	17.75896	-2.508958
6	0.0000000	14.38867	-14.38868
7	22.50000	19.51969	2.980311
8	17.00000	31.96205	-14.96206
9	13.50000	12.86158	0.6384159
10	0.0000000	1.724390	-1.724392
11	22.00000	32.54815	-10.54816
12	22.00000	31.31123	-9.311234
13	56.25000	21.72763	34.52236
14	10.50000	20.65434	-10.15435
15	27.00000	15.09095	11.90905
16	45.00000	31.34409	13.65591
17	12.00000	13.11731	-1.117309
18	30.00000	21.08031	8.919683
19	27.25000	30.53637	-3.286374
20	19.00000	19.51969	-0.5196890
21	16.50000	13.53297	2.967024
22	50.75000	28.28559	22.46440
23	13.50000	18.54642	-5.046426
24	0.0000000	16.65426	-16.65427
25	17.15000	17.74344	-0.5934449
26	20.50000	31.15598	-10.65598
27	37.50000	32.65089	4.849109



DURBIN-WATSON TEST OF RESIDUAL DIFFERENCES COMPARED BY CASE ORDER (SEQNUM).

VARIABLE LIST 1. REGRESSION LIST 1. DURBIN-WATSON TEST 2.67645

O-14

Area 7 - Plot of standardised residuals and table of observed and predicted U values w.r.t. El, Hl, Sl (area weighted)

FILE F1 (CREATION DATE = 06/17/83)

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * * VARIABLE LIST 1
REGRESSION LIST 1

DEPENDENT VARIABLE.. U

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
S1	0.24410	0.05958	0.05958	0.24410	[illegible]	0.7350
H1	0.49612	0.24613	0.18655	-0.15597	-0.946[illegible]	-0.88[illegible]1
E1	(o.c) 0.52[illegible]39	0.27365	0.02771	0.06119	0.[illegible]7	0.3[illegible]
(CONSTANT)					-0.167[illegible]	

0-15

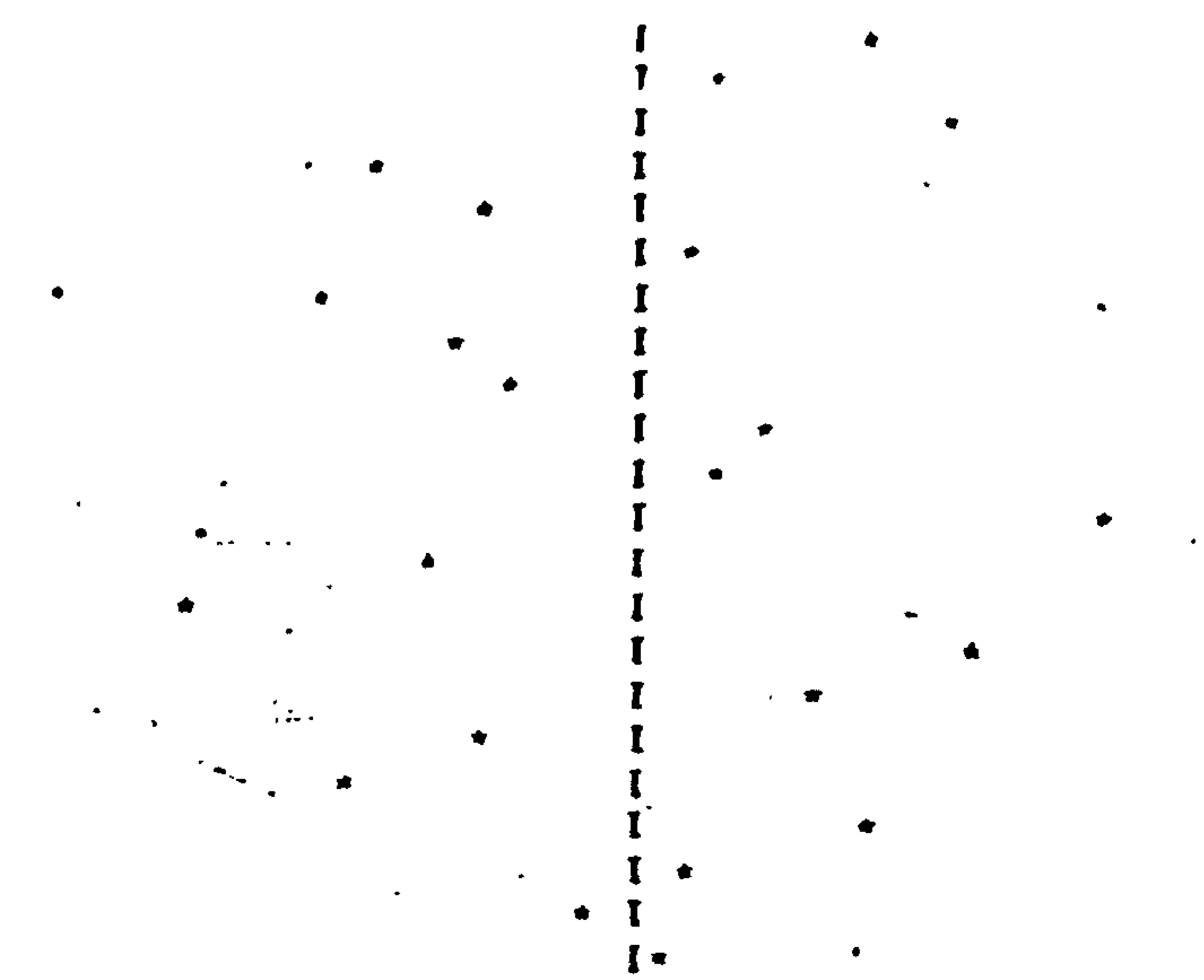
Area 1 - Multiple Regression Analysis for U with E1, S1, H1 (Total Weighted)

. . . . M U L T I P L E   R E G R E S S I O N . . . .

DEPENDENT VARIABLE: U   FROM   VARIABLE LIST 1
REGRESSION LIST 1

SEQNUM	OBSERVED U	PREDICTED U	RESIDUAL
1	22.00000	8.726072	13.27392
2	25.85000	21.29628	4.553717
3	46.00000	28.89263	17.10736
4	0.0000000	14.54458	-14.54458
5	0.0000000	8.604166	-8.604170
6	22.50000	19.51421	2.985793
7	15.75000	33.41439	-17.66440
8	0.0000000	9.514046	-9.514043
9	0.0000000	7.834135	-7.834137
10	28.00000	20.78061	7.219389
11	37.00000	33.30247	3.697518
12	38.00000	12.45377	25.54623
13	0.0000000	11.33718	-11.33718
14	0.0000000	24.24189	-24.24189
15	42.00000	22.89976	19.10024
16	27.50000	17.47781	10.02219
17	22.00000	30.63920	-8.639202
18	0.0000000	16.12756	-16.12756
19	32.00000	18.58221	13.41779
20	22.50000	19.59761	2.902384
21	15.50000	18.21826	-2.718263
22	32.00000	30.60111	1.398884

PLOT OF STANDARDIZED RESIDUAL
-2.0   -1.0   0.0   1.0   2.0



DURBIN-WATSON TEST OF RESIDUAL DIFFERENCES COMPARED BY CASE ORDER (SEQNUM).

VARIABLE LIST 1, REGRESSION LIST 1.   DURBIN-WATSON TEST   2.04906

0–16

Area 1 – Plot of standardised residuals and table of observed and predicted U values w.r.t. El, Hl, Sl (total weighted)

FILE F1 (CREATION DATE = 06/17/83)

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * * *

DEPENDENT VARIABLE.. U

VARIABLE LIST 1
REGRESSION LIST 1

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
E1	0.53899	0.29051	0.29051	-0.538[illegible]	-0.[illegible]	-[illegible].411[illegible]
S1	0.54113	0.29285	0.00234	0.448[illegible]	0.4[illegible]7[illegible]	[illegible].05[illegible]
H1	(o.c) 0.54223	0.29402	0.00117	0.4734[illegible]	0.40126[illegible]E-01	0.[illegible]7[illegible]
(CONSTANT)					33.5[illegible]7[illegible]	

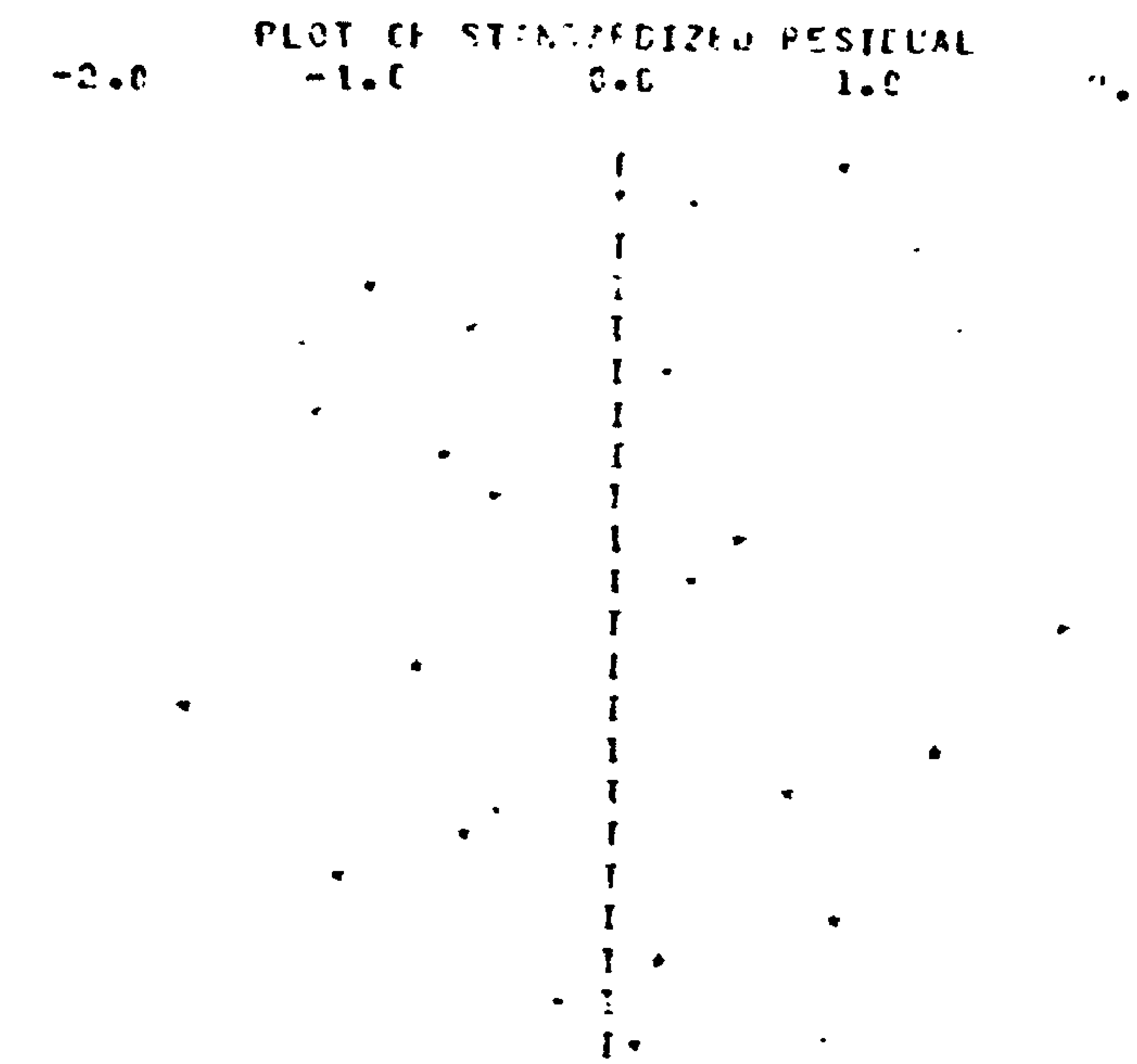
0-17

Area 2 - Multiple Regression Analysis for U with E1, S1, H1 (Total Weighted)

* M U L T I P L E   R E G R E S S I O N * * * * * * * * * * * * * *

DEPENDENT VARIABLE.. U   FROM VARIABLE LIST 1
                                      REGRESSION LIST 1

SEQNUM	OBSERVED U	PREDICTED U	RESIDUAL
1	[illegible]	[illegible]	[illegible]
2	[illegible]	[illegible]	[illegible]
3	[illegible]	[illegible]	17.10736
4	[illegible]	[illegible]	[illegible]
5	[illegible]	[illegible]	-8.604170
6	22.50000	[illegible]	[illegible]
7	15.75000	[illegible]	-17.66440
8	0.0000000	[illegible]	[illegible]
9	0.0000000	[illegible]	-7.834137
10	28.00000	20.78061	7.219359
11	37.00000	33.30247	3.697518
12	38.00000	12.45377	25.54623
13	0.0000000	11.53718	-11.53718
14	0.0000000	24.24189	-24.24199
15	42.00000	22.89976	19.10024
16	27.50000	17.47781	10.02219
17	22.00000	30.63920	-8.639292
18	0.0000000	16.12756	-16.12756
19	32.00000	18.58221	13.41779
20	22.50000	19.59761	2.902384
21	15.50000	18.21876	-2.718263
22	32.00000	[illegible]	[illegible]



DURBIN-WATSON TEST OF RESIDUAL DIFFERENCES COMPARED BY CASE ORDER (SEQNUM).

VARIABLE LIST 1, REGRESSION LIST 1.   DURBIN-WATSON TEST   2.04906

0-18

Area 2 - Plot of standardised residuals and table of observed and predicted U values w.r.t. E1, H1, S1 (total weighted)

FILE F1 (CREATION DATE = 05/17/85)

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * * VARIABLE LIST 1
DEPENDENT VARIABLE.. U REGRESSION LIST 1

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
S1	0.37108	0.13770	0.13770	0.37108	2.242545	0.37550
H1	0.37411	0.13996	0.00225	0.12761	-0.1132194	-0.13778
E1	(o.c) 0.37796	0.14285	0.00289	-0.36661	-0.1354025	-0.13572
(CONSTANT)					15.70151	

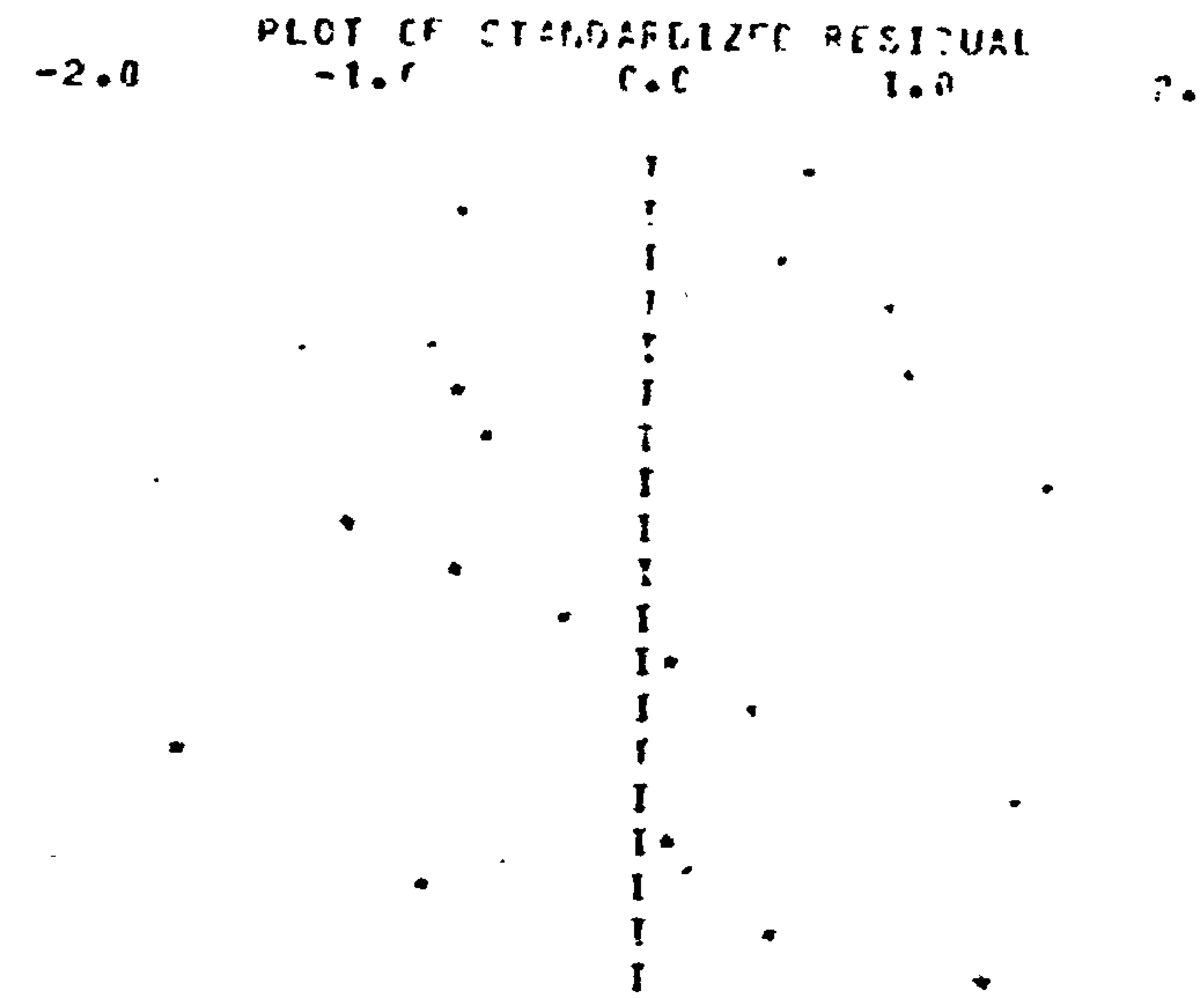
0-19

Area 3 - Multiple Regression Analysis for U with E1, S1, H1 (Total Weighted)

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * *

DEPENDENT VARIABLE: U FROM VARIABLE LIST 1
REGRESSION LIST 1

SEQNUM	OBSERVED U	PREDICTED U	RESIDUAL
1	[illegible]	27.0464[illegible]	8.95[illegible]42
2	[illegible]	8.635372	-8.635975
3	14.00000	8.599859	5.400137
4	36.50000	24.65321	11.84678
5	0.0000000	10.46331	-10.46332
6	0.0000000	8.854900	-8.854904
7	15.50000	22.74210	-7.242104
8	28.00000	8.635975	19.36403
9	15.63000	30.64421	-15.01422
10	16.00000	25.49210	-9.492102
11	14.50000	18.29873	-3.798730
12	31.17000	29.59829	1.571718
13	25.50000	20.11135	5.388666
14	0.0000000	21.96771	-21.96771
15	42.00000	23.92122	18.07877
16	20.00000	18.92318	1.076823
17	0.0000000	10.58371	-10.58371
18	16.00000	11.30302	4.696975
19	36.50000	18.82469	17.67531



DURBIN-WATSON TEST OF RESIDUAL DIFFERENCES COMPARED BY CASE ORDER (SEQNUM).

VARIABLE LIST 1, REGRESSION LIST 1. DURBIN-WATSON TEST 2.41812

0-20

Area 3 - Plot of standardised residuals and table of observed and predicted U values w.r.t. E1, H1, S1 (total weighted)

FILE F1 (CREATION DATE = 06/17/83)

. . . . M U L T I P L E   R E G R E S S I O N . . . . VARIABLE LIST 1
REGRESSION LIST 1

DEPENDENT VARIABLE.. U

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
E1	0.19422	0.03772	0.03772	-0.194[illegible]	-[illegible]	-0.4[illegible]
S1	0.24986	0.06243	0.02471	-0.018[illegible]	-[illegible]	-0.214[illegible]
H1	(o.c) 0.29316	0.08594	0.02351	0.0613[illegible]	-.15[illegible]	-.2[illegible]
(CONSTANT)					37.4771[illegible]	

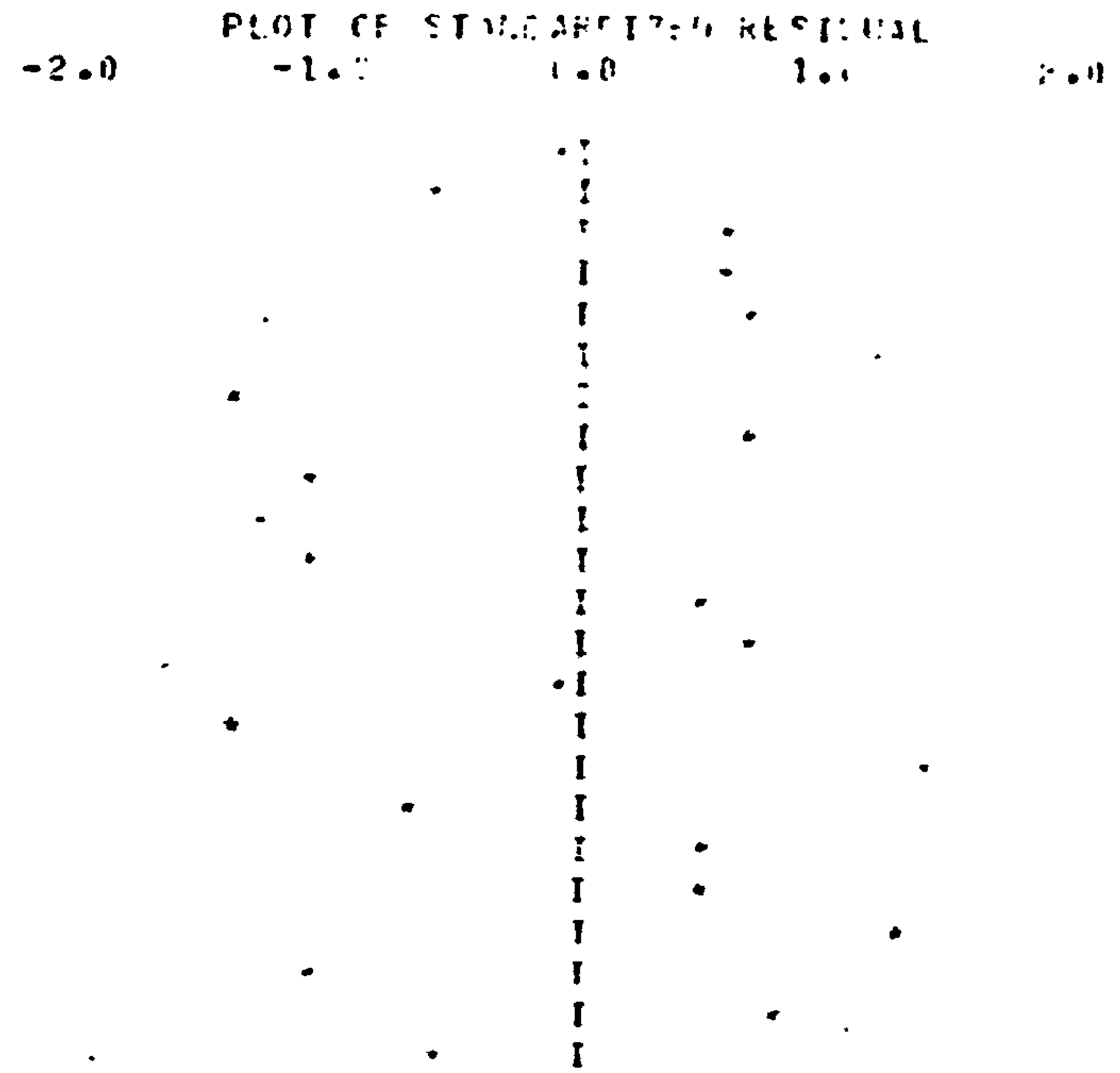
0–21

Area 4 – Multiple Regression Analysis for U with E1, S1, H1 (Total Weighted)

. . . . M U L T I P L E   R E G R E S S I O N . . . .

DEPENDENT VARIABLE: U   FROM   VARIABLE LIST 1
                                              REGRESSION LIST 1

SEQNUM	OBSERVED U	PREDICTED U	RESIDUAL
1	19.00000	20.02583	-1.025832
2	16.00000	25.12[illegible]	-9.12[illegible]31
3	30.00000	21.47834	8.521662
4	21.00000	12.94441	8.055559
5	33.00000	22.30439	10.69561
6	37.00000	18.41903	18.58097
7	0.0000000	22.06002	-22.06002
8	19.00000	8.553236	10.44676
9	0.0000000	16.97405	-16.97405
10	0.0000000	19.70782	-19.70783
11	0.0000000	16.41719	-16.41720
12	17.50000	9.552574	7.947425
13	18.00000	7.591252	10.40874
14	19.00000	19.97455	-0.9745536
15	0.0000000	20.81214	-20.81214
16	47.00000	24.94643	22.05357
17	0.0000000	10.47937	-10.47938
18	17.50000	9.656427	7.843571
19	28.00000	19.76455	8.235447
20	46.50000	27.24451	19.25548
21	0.0000000	17.09740	-17.09740
22	30.25000	17.86908	12.38092
23	0.0000000	9.656427	-9.656429



DURBIN-WATSON TEST OF RESIDUAL DIFFERENCES COMPARED BY CASE ORDER (SEQNUM).

VARIABLE LIST 1, REGRESSION LIST 1.   DURBIN-WATSON TEST   2.46686

Area 4 – Plot of standardised residuals and table of observed and predicted U values w.r.t. E1, H1, S1 (total weighted)

FILE F1 (CREATION DATE = 06/17/83)

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * * VARIABLE LIST 1
REGRESSION LIST 1

DEPENDENT VARIABLE.. U

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
H1	0.28024	0.07853	0.07853	0.28024	0.1594787	[illegible]
S1	0.29624	0.08776	0.00922	0.26572	0.6103681	0.17464
E1	(o.c) 0.30404	0.09244	0.00468	-0.25870	0.1367498	0.24237
(CONSTANT)					16.10300	

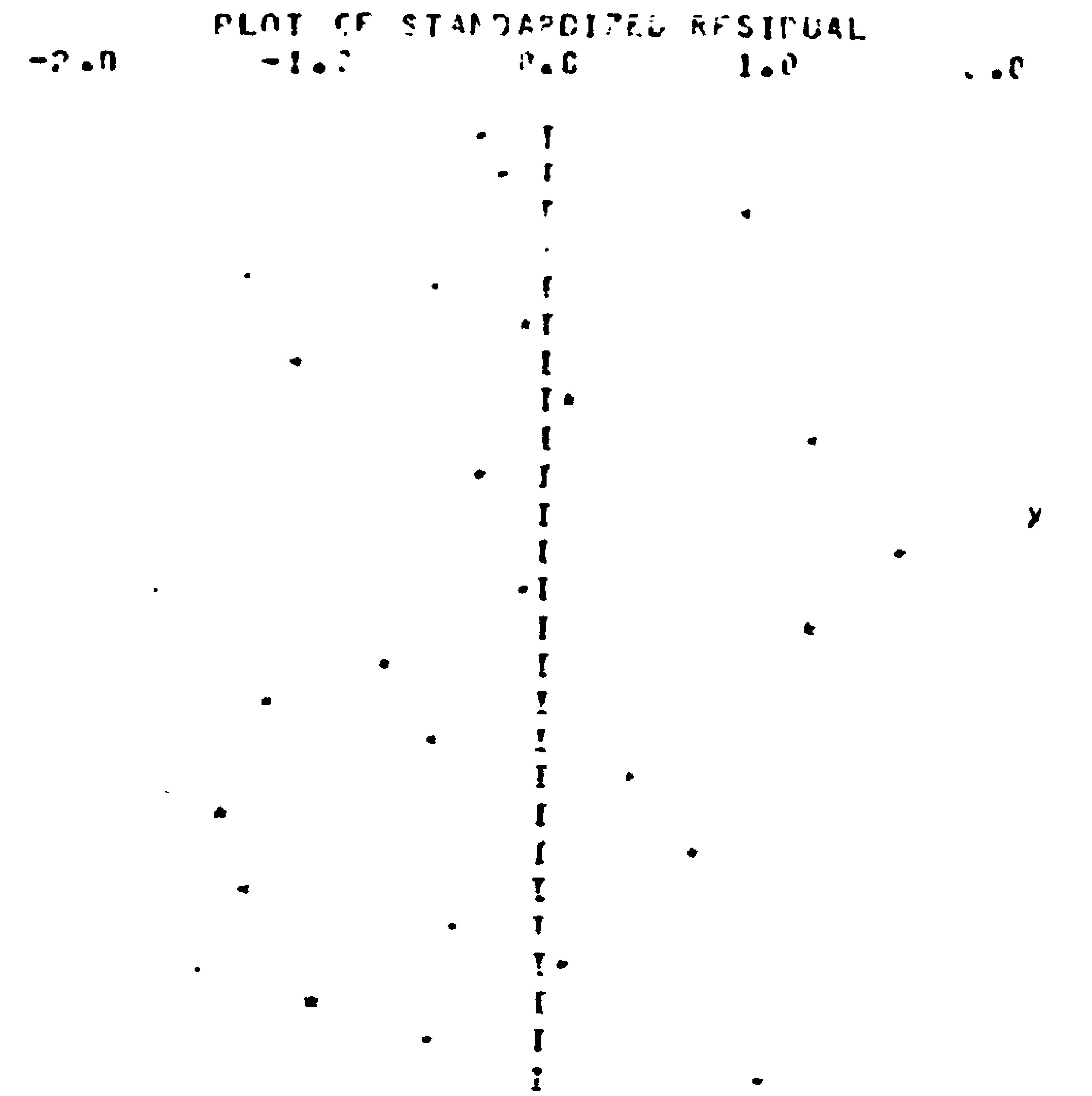
0-23

Area 5 - Multiple Regression Analysis for U with E1, S1, H1 (Total Weighted)

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * *

DEPENDENT VARIABLE: U FROM VARIABLE LIST 1
REGRESSION LIST 1

SEQNUM	OBSERVED U	PREDICTED U	RESIDUAL
1	21.75000	25.59773	-4.847713
2	18.33300	20.42978	-2.494783
3	37.00000	23.59423	13.40576
4	22.00000	22.46650	-0.4665073
5	17.00000	24.21416	-7.214158
6	20.00000	29.80087	-9.8008657
7	0.0000000	16.83458	-16.83459
8	22.00000	20.75639	1.243607
9	43.00000	24.56024	18.43976
10	22.25000	27.24023	-4.990231
11	55.37000	20.47934	34.89066
12	52.50000	29.02290	23.47710
13	22.75000	24.15507	-1.405071
14	38.00000	19.94429	18.05571
15	20.75000	30.50792	-9.757927
16	0.0000000	18.10106	-18.10107
17	16.83000	23.79760	-6.917609
18	23.00000	17.72480	5.275200
19	0.0000000	20.17571	-20.17571
20	32.50000	22.67320	9.826794
21	0.0000000	19.03428	-19.03429
22	14.00000	19.71789	-5.717895
23	21.00000	19.71789	1.282106
24	20.25000	34.80166	-14.55166
25	20.00000	27.82265	-7.822649
26	37.50000	21.92900	15.57100



DURBIN-WATSON TEST OF RESIDUAL DIFFERENCES COMPARED BY CASE ORDER (SEQNUM).

VARIABLE LIST 1, REGRESSION LIST 1. DURBIN-WATSON TEST 1.87838

Area 5 – Plot of standardised residuals and table of observed and predicted U values w.r.t. E1, H1, S1 (total weighted)

FILE F1 (CREATION DATE = 06/17/83)

. . . . M U L T I P L E R E G R E S S I O N . . . . VARIABLE LIST 1

DEPENDENT VARIABLE.. U REGRESSION LIST 1

SUMMARY TABLE

VARIABLE		MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
[illegible]		0.65394	0.42764	0.42764	0.65394	[illegible]	[illegible]
E1	(0.37)	0.65974	0.43525	0.00761	-0.57030	[illegible]	0.22722
(CONSTANT)						29.232[illegible]	

0-25

Area 6 - Multiple Regression Analysis for U with E1, S1, H1 (Total Weighted)

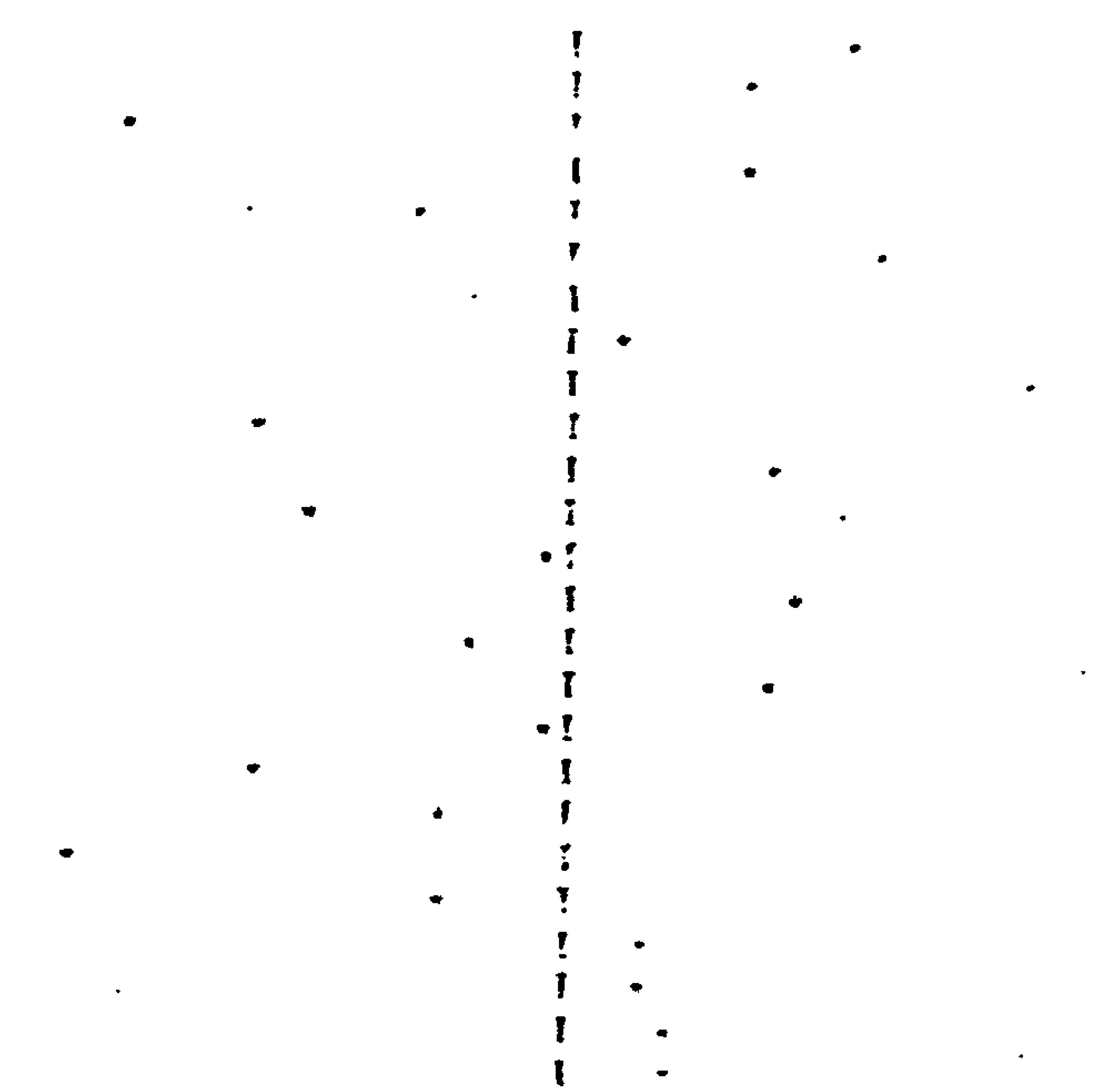
* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * * *

DEPENDENT VARIABLE: U FROM VARIABLE LIST 1
REGRESSION LIST 1

SEQNUM	OBSERVED U	PREDICTED U	RESIDUAL
1	24.45[illegible]	12.47114	11.97886
2	20.85[illegible]	13.33762	7.512577
3	0.0000000	12.19686	-12.19687
4	27.[illegible]	1[illegible].73531	8.194685
5	12.00000	17.14534	-7.145330
6	31.00000	17.04311	12.95688
7	13.47[illegible]	18.61327	-4.643273
8	20.00000	17.60791	2.392093
9	38.00000	17.86954	20.11045
10	0.0000000	13.52753	-13.52753
11	31.50000	22.58792	8.912079
12	0.0000000	10.53531	-10.53531
13	13.00000	14.02683	-1.026833
14	25.00000	15.46741	9.532583
15	9.750000	14.64515	-4.895136
16	22.00000	13.07227	8.927732
17	11.50000	12.98424	-1.484236
18	0.0000000	12.92874	-12.92874
19	8.94[illegible]	13.12777	-5.077768
20	0.0000000	20.48836	-20.48837
21	7.7[illegible]	13.51799	-5.717996
22	16.75000	13.52753	3.222467
23	22.50000	13.79484	8.705116
24	18.00000	13.52745	4.472466
25	15.00000	10.26042	4.739581

PLOT OF STANDARDIZED RESIDUAL

-2.0 -1.0 0.0 1.0 2.0



DURBIN-WATSON TEST OF RESIDUAL DIFFERENCES COMPARED BY CASE ORDER (SEQNUM).

VARIABLE LIST 1. REGRESSION LIST 1. DURBIN-WATSON TEST 2.43166

0–26

Area 6 – Plot of standardised residuals and table of observed and predicted U values w.r.t. El, Hl, Sl (total weighted)

FILE F1 (CREATION DATE = 06/17/83)

* M U L T I P L E   R E G R E S S I O N * * * * * * * * * * * * * * * VARIABLE LIST 1
REGRESSION LIST 4

DEPENDENT VARIABLE.. U

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R		BETA
H1	0.50282	0.25283	0.25284	0.50282	0.79[illegible]877	0.71[illegible]
E1	0.57452	0.33008	0.077[illegible]	-0.14200	0.[illegible]756458	0.44182
S1	(0.29) 0.60712	0.36860	0.038[illegible]	0.32816	1.13713[illegible]	0.22115
(CONSTANT)					15.83127	

0-27

Area 7 - Multiple Regression Analysis for U with E1, S1, H1 (Total Weighted)

. . . . M U L T I P L E   R E G R E S S I O N . . . .

DEPENDENT VARIABLE: U   FROM VARIABLE LIST 1
REGRESSION LIST 1

PLOT OF STANDARDIZED RESIDUAL
-2.0 -1.0 0.0 1.0 2.0

SEQNUM	OBSERVED U	PREDICTED U	RESIDUAL
1	27.00000	34.28410	-7.284520
[illegible]	41.7[illegible]	31.124[illegible]	2.[illegible]
[illegible]	5.27[illegible]	[illegible]	-6.[illegible]236
[illegible]	31.0[illegible]	32.798[illegible]	-1.[illegible]352
[illegible]	17.00000	26.2120[illegible]	-9.212084
6	27.00000	34.53272	-7.532724
7	18.25000	19.375[illegible]	-1.125659
8	34.00000	34.88171	-0.8817124
9	60.50000	35.35284	25.14715
10	31.00000	35.58440	-4.584398
11	29.00000	32.52377	-3.523777
12	32.00000	34.51412	-2.514125
13	31.75000	32.88331	-1.133309
14	35.75000	33.01463	2.735367
15	46.25000	38.40833	7.841661
16	30.36000	38.54951	-8.189512
17	37.00000	36.84457	0.1554264
18	37.00000	34.42750	2.572406
19	42.50000	34.4839[illegible]	8.016156
20	33.25000	9.922832	23.32716
21	0.0000000	16.98746	-16.98747

DURBIN-WATSON TEST OF RESIDUAL DIFFERENCES COMPARED BY CASE ORDER (SEQNUM).

VARIABLE LIST 1, REGRESSION LIST 1. DURBIN-WATSON TEST 2.09345

0-28

Area 7 - Plot of standardised residuals and table of observed and predicted U values w.r.t. E1, H1, S1 (total weighted)

APPENDIX P

FILE F1 (CREATION DATE = 06/17/83)

. . . . M U L T I P L E R E G R E S S I O N . . . . VARIABLE LIST 1
REGRESSION LIST 1

DEPENDENT VARIABLE.. USAGE

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
SEG	0.66942	0.44812	0.44812	0.66942	[illegible]	[illegible]
HOUSE	0.81968	0.67188	0.22376	0.66456	0.4386656	0.43365
EMPLOY	(0.58) 0.82096	0.67398	0.00210	-0.56561	-0.50217[illegible]E-01	-0.06534
(CONSTANT)					15.19073	

P-1

Multiple Regression Analysis for USAGE with HOUSE, EMPLOY & SEG
(Means Data Without Variable S)

* M U L T I P L E   R E G R E S S I O N * * * * * * * * * * * * * *

DEPENDENT VARIABLE:: USAGE FROM VARIABLE LIST 1
REGRESSION LIST 1

SEGNUM	OBSERVED USAGE	PREDICTED USAGE	RESIDUAL	PLOT OF STANDARDIZED RESIDUAL -2.0 -1.0 0.0 1.0 2.0
1	19.50000	20.87267	-1.372671	* I
2	18.50000	18.88260	-0.3826069	*I
3	17.40000	17.48575	-0.8575657E-01	*
4	23.00000	27.32558	-4.325589	* I
5	15.50000	14.95916	0.5408381	I *
6	30.30000	24.03026	6.269734	I *
7	22.50000	23.96526	-1.465266	* I
8	23.50000	22.11913	1.380866	I *
9	20.30000	22.70251	-2.402513	* I
10	19.90000	20.08342	-0.1834199	*I
11	28.50000	28.98786	-0.4878691	* I
12	30.50000	28.72716	1.772835	I *
13	18.59999	22.25792	-3.657932	* I
14	27.90000	23.82342	4.076573	I *
15	22.40000	22.07922	0.3207747	I*

DURBIN-WATSON TEST OF RESIDUAL DIFFERENCES COMPARED BY CASE ORDER (SEGNUM).

VARIABLE LIST 1, REGRESSION LIST 1. DURBIN-WATSON TEST 2.61651

P-2

Plot of standardised residuals and table of observed and predicted USAGE values w.r.t. HOUSE, EMPLOYMENT AND SEG (Means Data without variable S)

FILE F1 (CREATION DATE = 06/17/83)

* M U L T I P L E   R E G R E S S I O N * * * * * * * * * * * * * *

DEPENDENT VARIABLE.. USAGE

VARIABLE LIST 1
REGRESSION LIST 1

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
SEG	0.66942	0.44812	0.44812	0.66942	0.7[illegible]	0.[illegible]
EMPLOY	0.78457	0.61555	0.16743	-0.5[illegible]	-0.[illegible]	-0.[illegible]
HOUSE	0.80723	0.65161	0.03606	0.[illegible]	0.4[illegible]E-01	0.[illegible]
(CONSTANT)					21.611[illegible]	

(c-56)

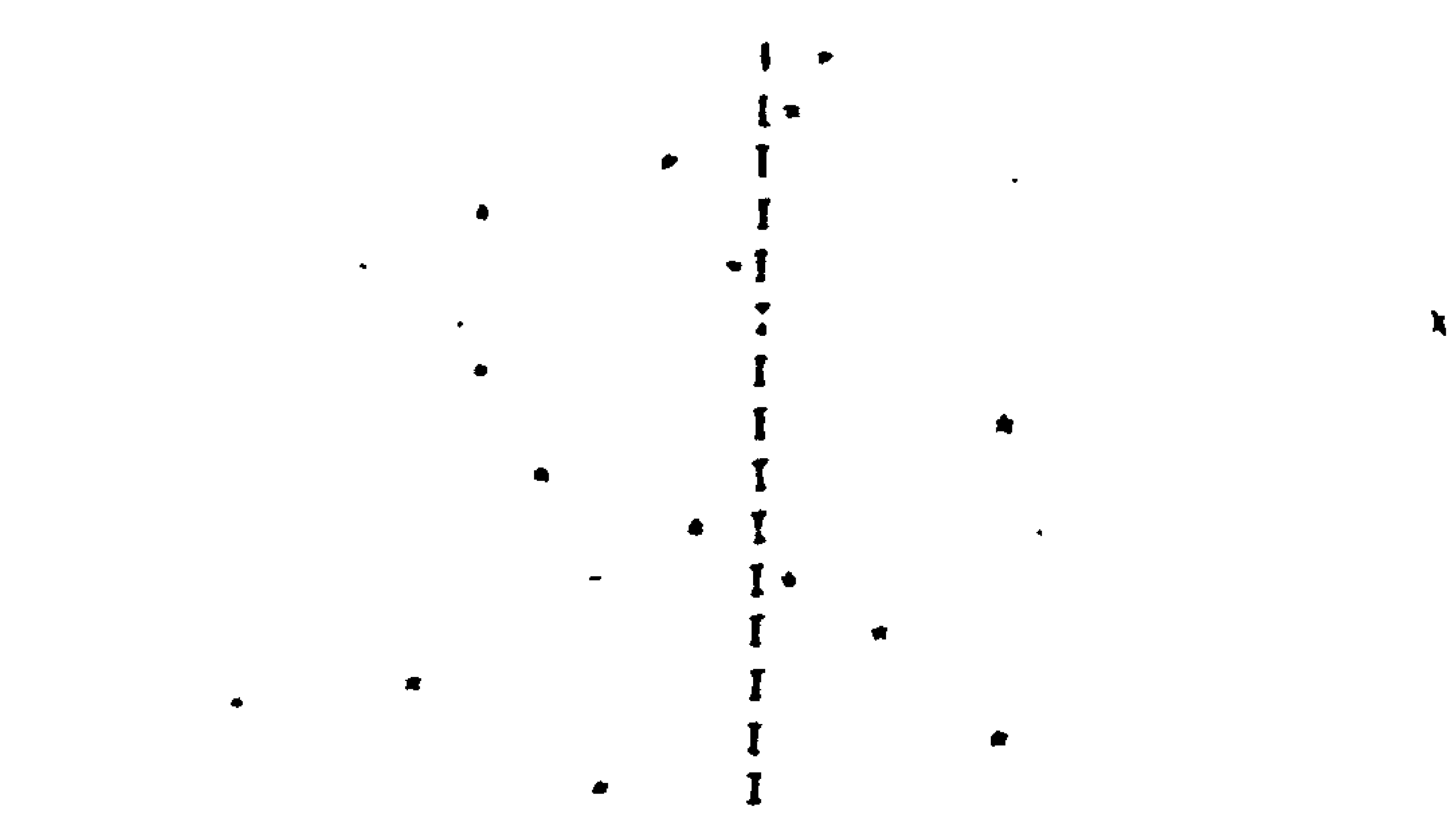
P-3

Multiple Regression Analysis for USAGE with HOUSE, EMPLOY & SEG
(Means Data With S)

* M U L T I P L E   R E G R E S S I O N * * * * * * * * * * * * * * *

DEPENDENT VARIABLE: USAGE   FROM   VARIABLE LIST 1
REGRESSION LIST 1

SEGNUM	OBSERVED USAGE	PREDICTED USAGE	RESIDUAL	PLOT OF STANDARDIZED RESIDUAL -2.0 -1.0 0.0 1.0 2.0
1	19.50000	18.92015	0.5798385	
2	18.50000	18.26396	0.2360035	
3	17.40000	18.48917	-1.089170	
4	23.00000	25.84574	-2.845742	
5	15.50000	15.67080	-0.1707979	
6	30.30000	22.65275	7.647245	
7	22.50000	25.43814	-2.938150	
8	23.50000	20.97197	2.528022	
9	20.30000	22.63167	-2.331677	
10	19.90000	20.64667	-0.7466705	
11	28.50000	28.29711	0.2028859	
12	30.50000	29.09676	1.403239	
13	18.59999	22.03358	-3.433388	
14	27.90000	25.50528	2.394711	
15	22.40000	23.83635	-1.436359	



DURBIN-WATSON TEST OF RESIDUAL DIFFERENCES COMPARED BY CASE ORDER (SEGNUM).

VARIABLE LIST 1, REGRESSION LIST 1.   DURBIN-WATSON TEST   2.84905

P-4

Plot of standardised residuals and table of observed and predicted USAGE values w.r.t. HOUSE, EMPLOYMENT AND SEG (Means Data with variable S)